POWER

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Overmanned Industries

WHEN communities were small and self-sufficient, the prices of commodities were naturally kept down by competition. If one farmer charged too much for his milk or hay, customers flocked to others who were more reasonable. A cobbler with inflated ideas as to the value of his services would last only until another with less exalted notions could be installed.

But things have changed. The shoemaker has given place to the shoe factory, the grist mill to the great milling companies, the woodyard to the coal company, the butcher to the packing house.

If prices get to where the consumer thinks they are too high, what is he going to do about it? It takes money to start a chain of shoe factories or of packing companies.

And if somebody with money and nerve and influence enough did start a rival organization in any of the existing lines, what would be the result?

There is enough plant, machinery and organization now to supply the demand at current prices. If the new establishment made a material reduction in selling price, it might create a somewhat wider demand besides attracting a part of the old, but even with this increased demand there would be too much plant for the necessities of the country in that particular line. Both plants run continuously at full capacity would produce more of the commodity than could be absorbed.

But a factory must be run at capacity to be efficient. Otherwise the overhead per unit of product is excessive.

The over-investment in plant and men to do this job is an economical misadventure, for which in some way or another the users of that product will eventually pay.

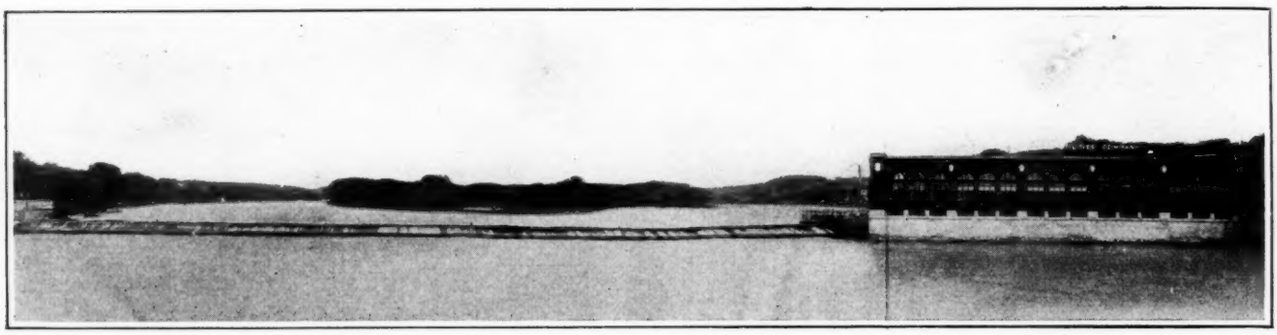
There are a number of lines that are overdeveloped, over-installed, over-manned already. The bituminous coal industry is a notable example.

At a recent meeting of one of the trade associations in the power line it was frankly admitted that in the aggregate there were more facilities installed than could be kept busy at a fair use factor to supply the normal demand.

If each has to carry its overhead and make a full-time profit on part-time work, the user must pay the freight, just as he does for keeping a lot of miners around all the time to work when the demand comes.

Competition is dead, the law of supply and demand is hamstrung. The thinking man is beginning to realize that the big way to run the nation's productive department is the right way; that one great company realizing all the economies of aggregation, expert management, collective buying and selling is more efficient than a lot of smaller concerns spending their productive and selling energies in competition. And the public is getting ready to approve monopoly if it can be assured of immunity from imposition and unconscionable profits.

F. R. Low



With 8-foot head on the dam water is backed up the river for 9 miles

Largest Seven-Foot Head Hydro-Electric Plant

PRESENT capacity five units of 800 kva. each operating at 80 r.p.m. on 7-ft. effective head. Operated by two men as base-load plant in conjunction with near-by steam plant. Space limitations imposed by previous installation and by State Rivers Commission necessitated use of diagonal type of power house and other interesting construction work.

ON THE Rock River at Dixon, Ill., the Illinois Northern Utilities Co. has put into successful operation the largest hydro-electric plant in the world operating on less than 8-ft. head. The present construction consists of five 800-kva. vertical-shaft generating units each directly connected to a single-runner hydraulic turbine operating under an effective head of 7 ft. at full plant capacity. The complicated flowage rights, the limited site space, the low head and large volume of water per unit made the design and construction of this plant particularly difficult in obtaining maximum economy of operation as well as keeping the initial investment within limits set by the production cost of electrical power.

The average annual output of the plant is estimated to be 13,350,000 kw.-hr. The entire plant is operated by a switchboard attendant and a helper or floor man.

The average annual stream flow is about 5,600 sec.-ft. Ordinary flood flow is 15,000 to 20,000 sec.-ft., while maximum occasional flood is probably 50,000. The river in the neighborhood of Dixon has a small slope and only low heads are available. The pond with the existing 8-ft. dam has a length of about 9 miles and an area of about 800 acres. The total flow capacity of the completed development has been set at about 7,700 sec.-ft., permitting a wastage of flood water for about 20 per cent of the time of the average year. The present power house provides for a water capacity of 5,500 sec.-ft. at 8-ft. head.

The water-power development of the Rock River at Dixon is one of the oldest in the state. Electric power was first used in the City of Dixon in 1890 when a company was formed to light the city. In about 1905 this company acquired a considerable portion of the water power of the Rock River for a hydro-electric development from the old headrace. In 1912 the local electric company sold all its holdings, including the power plant and water-power rights in the Rock River, to the present owner, the Illinois Northern Utilities Co., a subsidiary of the Middle West Utilities Company.

Since 1912 the present owner has from time to time acquired properties and shares and at the period of beginning this new construction was the owner of all of the property except a small holding by the Reynolds Wire Co. An agreement between the two parties on a basis that recognized all the rights and benefits accruing to each, finally made possible the present construction.

In the existing construction the spillway and the concrete entrance work to the headrace were last reconstructed in about 1904. The spillway was a timber crib rock-filled structure planked over and with 16-in. flash boards. The length of the spillway was 715 ft. and the crest was about 8½ ft. above the low-water mark. At the north end of the spillway was a masonry and concrete retaining wall with an earth fill to the river bank. At the south end of the spillway was a concrete gravity-section retaining wall which was extended upstream to form a barrier and intake to the headrace. Water entered the headrace through a number of submerged openings in this barrier wall for which gates were provided.

The hydro-electric power houses took water from the headrace—that of the Illinois Northern Utilities Co. containing three wheels installed in about 1904, and the Reynolds Wire Co. plant containing two wheels installed in 1915. The total water capacity of the two plants at full load was about 1,300 sec.-ft. under 8 ft. head, but the restricted headrace gave much lower head for full plant operation. The shore side of the headrace consisted of a concrete gravity section wall carried up to the street level.

The limitations imposed by the restrictions to the space available for the site of the proposed development was the primary consideration in the determination of the type of the development used. These restrictions may be summarized as follows:

Fig. 1—Generators have been raised four feet above the power-house floor primarily to obtain proper ventilation through the units

On account of the low head and the large quantity of water required by the turbines (1,100 sec.-ft. each) they were installed in siphon settings in which a vacuum is maintained. The turbines have runners of the propeller type, are guaranteed to deliver power over a range from 280 hp. at 4-ft. head with a maximum efficiency of 68.5 per cent to 925 hp. with a maximum efficiency of 90 per cent at 9-ft. head; all at 80 r.p.m. Tests on the model runners indicated that probably 2 per cent better efficiency than that guaranteed would be obtained.

1. The north side of the river was owned by the company, but rock lies deep and the foundation would be entirely on gravel and the river depths below the spillway on this side range from 20 to 30 ft., requiring excessive construction costs. A plant at the north side of the river could not be located to the best advantage of the company.

2. The privately owned ground along the river below the dam had been filled out to a shore line set by the State Rivers Commission approximately 175 ft. from the south line of construction at the company's property line.

3. A shore line has been substantially fixed by the State Commission upstream of the proposed construction.

4. The length of the spillway on the dam before beginning operations was 715 ft., and while some little extension of the dam could be made at the north end, it was not desirable to attempt to rebuild the dam at this time. Some shortening of the spillway was permissible, but only by maintaining substantially the same flood capacity as prevailed prior to the time of beginning construction. The old headworks and plant construction made the headrace of little value in passing flood water. The State Rivers Commission permitted a reduction in the length of spillway upon being satisfied the waterway of the new construction would have flood capacity equivalent to the short section of the open spillway removed.

These limitations required that the maximum clear waterway be made between the southern boundary of the company property and the end of the spillway and that the plant design be such as would make full effective use of such waterway. The downstream shore line required the new construction to be sufficiently upstream to permit waterway space for the discharge of the plant to the river. The type of wheels necessary to meet operating conditions required draft-tube width greater than that necessary for bringing water into the wheels.

In meeting these conditions use was made of the diagonal type of power house which had been used and patented some time before by the engineers. This particular type of power house permitted the net width of the draft pit per unit (center to center distance of units) to be greater than the width of the wheelpit, and the center of the unit to be placed off center in the wheelpit while at the same time to be on the center line of the draftpit. Placing the unit off center in the wheelpit gives a more even distribution of water throughout the width of the wheelpit.

From the viewpoint of economy it was desirable that each generating unit of the power house be as large as was practicable while obtaining high efficiencies for the entire unit. The low effective head available particularly under full load conditions of about seven feet made it necessary that the vacuum type of wheelpit be used. The success of the entire development therefore depended largely upon satisfactorily handling the large quantities of water at reasonable velocities and without undue disturbance.

The diagonal type of plant construction, which at first thought might seem unnecessarily complicated, is in fact relatively simple, as the lower part of the structure up to and including the wheelpit floor is uniform and regular within itself. The wheelpit walls are then constructed on the wheelpit floor without reference, in the field at least, to the structures below the wheelpit floor.

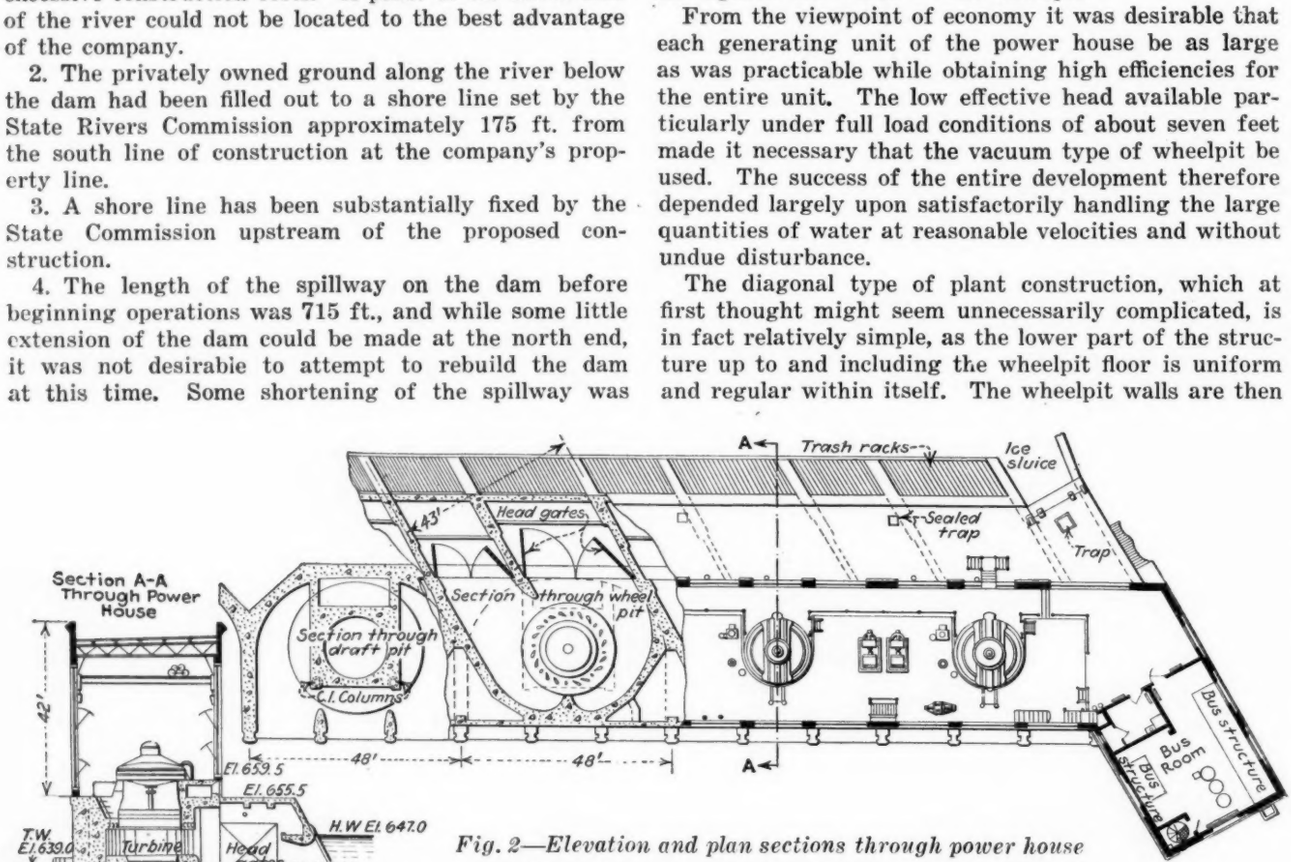


Fig. 2—Elevation and plan sections through power house

The diagonal type of power-house construction has been used. This type permits the net width of the draft-tube pit to be greater than the width of the wheel pit. In this installation the former is 48 ft. center to center and the latter is 43 ft. This construction also permits placing the turbine off center in the wheel pit and on the center of the draft-tube pit.

Fig. 2 shows a sectional plan and elevations of the power house. The trash-rack structure is of sufficient strength to permit bulkheading the rack opening if necessary. Under the trash-rack platform are wheelpit gates. These gates are hinged at the sides and swing like double doors and may be easily opened or closed by one or two men. The location of the turbines in the wheelpit is off the center line, and the wheelpit gates, of four leaves, are of different widths in order that the center supporting pier in the wheelpit might be located substantially on the center line of the unit. The lip seal at the top of the trash-rack opening provides a working space in operating the wheelpit gates. Filler gates are provided in the wheelpit gates to fill the wheelpit prior to opening the gates.

At the south end of the trash-rack platform an ice and trash sluice 20 ft. wide is provided through which floating débris and ice may be passed from the forebay to the tailrace under the power-house basement. The stuiceway is closed by a tainter gate, hand operated from the platform above. Provisions are made for picking up trash along the rack and loading on a car on the trash-rack platform and delivering the débris

through a trap door in the top of the sluice passageway.

The wheelpits are modified scroll type and because of the low head provide for a vacuum or siphon wheel setting. The entire wheelpit roof and trash-rack platform are designed for airtightness and to withstand the water load due to the siphon effect. Wheelpit drains to the draftpit take care of leakage through the wheelpit gates when the wheelpits are unwatered.

The draft tube, which is of the Moody spreading type, is of steel plate and is encased in concrete down to the flare. The edges of the plate tube are anchored to the floor with columns. Within the steel draft tube is a heavily reinforced concrete center cone reaching to a cast-iron cap at the bottom of the runner. The top of the wheelpit roof is the generator floor, the generators having been raised 4 ft. above the floor, primarily to obtain proper ventilation through the unit.

In the new plant the principal equipment consists of five generating units, two motor-generator exciter sets and a rotary converter set. Hydraulic turbines and governors were furnished by the I. P. Morris Department of the Wm. Cramp & Sons Ship & Engine Building Co. Each turbine is an 800-hp. vertical-shaft, single-runner, concrete-cased type operating under a normal net head of 8 ft. at 80 r.p.m. These turbines, which have runners of the propeller type, were guaranteed to deliver power over a range from 280 hp. at 4-ft. head with a maximum efficiency of 68.5 per cent to 925 hp. with a maximum efficiency of 90 per cent at 9-ft. head, all at 80 r.p.m. The test of the model runners would indicate that probably 2 per cent greater efficiency than guaranteed would be had.

Speed control of each unit is by a Woodward oil-pressure actuator-type governor, each governor having

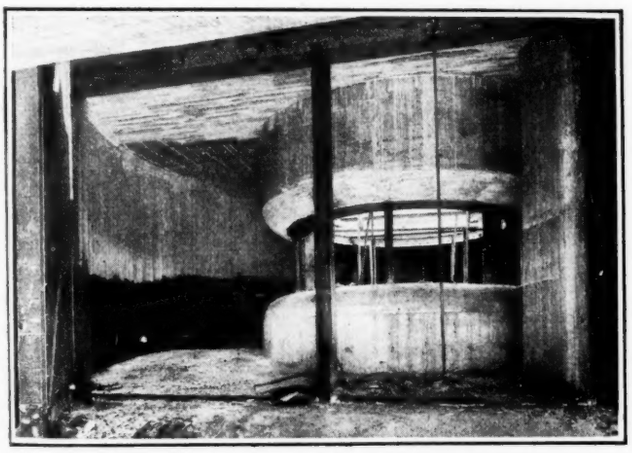


Fig. 3—Inside one of the wheelpits showing general construction

an individual pumping system consisting of a motor-driven rotary oil pump, an accumulator and sump tank.

Generators and motor-generator exciter sets were furnished by the Allis-Chalmers Manufacturing Co. Each generator is a vertical-shaft unit rated at 800 kva. when operating at 80 per cent power factor at 80 r.p.m. The machines are wound to deliver three-phase 60-cycle current at 2,300 or 4,000 volts and have a guaranteed efficiency of 91 and 93 per cent at unity power factor and 88 and 90 per cent at 80 per cent power factor for one-half and full loads respectively. Each generator is provided with a water-cooled thrust bearing.

Excitation for the plant is furnished by two induction motor-generator sets, each rated at 150 kw. at the direct-current end. When operating at 250 volts, direct current, each exciter is capable of furnishing excitation to all the main generators at power-factor conditions that ordinarily prevail on the system.

Although this plant is interconnected with other stations, it was found desirable to provide means for starting independently. For this service there has

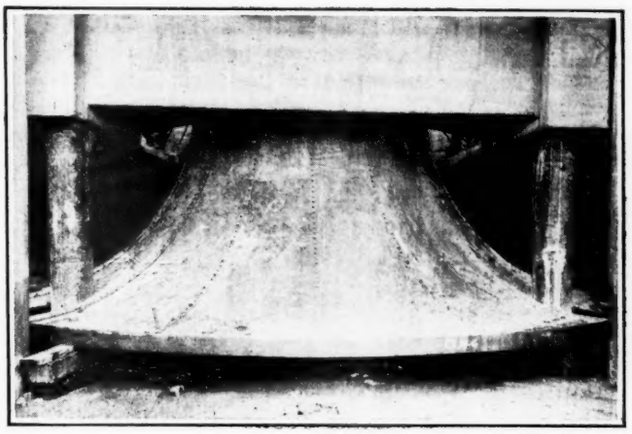


Fig. 4—Within the plate-steel draft tube is a reinforced-concrete core reaching up to the turbine runner

been installed a directly connected high-speed hydraulic turbine-generator unit rated at 5 kw., 125 volts, direct current.

The vacuum-type wheelpit necessary for the low-head installation requires means for removing the air from the wheelpit to obtain the full siphon effect. In this plant specially designed water-operated ejectors were provided in each wheelpit. In addition to these ejectors provisions were made to permit the installation of a motor-driven exhauster in the event that satisfactory air removal was not had with the ejectors. A siphon lift of 7 ft., when operating at a head of 7 ft., was necessary to fill the wheelpit completely, and the latter was necessary to obtain moderate water velocity.

Upon test of the plant, however, the ejectors produced a vacuum of 6½ in. of mercury, or more than sufficient to fill the wheelpit, so that it was unnecessary to use auxiliary means in maintaining the vacuum. It was found also from tests that satisfactory results were obtained without the use of the ejectors. A unit was started with the ejectors closed off and the water at the pond level. The turbine immediately acted as an air pump, lifting the water in the wheelpit well above the turbine gates, and the design of the water passage to the turbine gave a substantially uniform velocity over the width of the wheelpit, resulting in the ability of the unit to carry as satisfactory a load without the ejectors as with them. Consequently, there is no delay getting the unit on the line in emergency in spite of the fact that the normal pond water surface is below the top of the wheelpit gates.

All work, negotiations and contracts by the Illinois Northern Utilities Company were handled directly by E. D. Alexander, vice-president of the company. All engineering work was conducted by Holland, Ackerman & Holland, consulting engineers, of Chicago and Ann Arbor, C. J. McLean of their office being resident engineer on the project during construction.

Boiler Inspection in Holland

By H. Wieland Los

Since 1824 steam boilers in Holland have been subjected to interprovincial regulations, but the yearly reports of the chief engineer were not published until 1898. The writer has read through all the reports from 1898 till 1922 and compiled the accompanying table. After a boiler has seen 25 years of service, it must be cleared of its casing or lifted out of the stokehold of a vessel, in order that it may be inspected for otherwise hidden defects. Small vertical boilers are capsized so as to reveal the condition of the firebox, but fire-tube boilers are not only dismantled, but all the tubes of these boilers are removed to give the inspector a good

RESULTS OF HOLLAND BOILER INSPECTION

Year	No. of Boilers	No. of Unfired Pres. Vessels	No. of Internal Inspections	No. of Settings Removed	No. Cases Fire Tubes Entirely Removed	Accidents: Deaths	Accidents: Injuries	Deaths Directly from Explosions
1898	10,544	.....	6,295	...	...	..	3	..
1899	10,962	1,015	6,765	...	...	1	3	..
1900	11,481	1,240	6,680	195	...	1	3	..
1901	12,034	1,573	7,209	200	...	1	4	..
1902	12,080	1,778	7,373	181	...	2	5	..
1903	12,540	1,975	7,821	191	...	1	3	..
1904	12,882	2,116	7,746	238	...	5	8	..
1905	13,149	2,374	8,038	288	23	..	4	..
1906	13,450	2,583	8,114	415	30	1	2	4
1907	13,796	2,769	8,436	554	76	1	3	..
1908	14,170	2,961	8,367	337	42	..	7	7
1909	14,55?	3,286	8,841	413	78	3	5	..
1910	14,853	3,604	8,772	323	57	1	3	1
1911	15,173	3,944	9,064	473	88	..	2	7
1912	15,591	4,386	9,376	550	205	..	..	..
1913	16,119	4,895	9,340	636	158	5	8	1
1914	16,528	5,408	9,557	490	103	2	2	..
1915	15,372	4,014	9,580	539	106	1	2	..
1916	15,568	4,141	9,648	400	90	1	1	..
1917	15,527	4,216	9,267	588	163	..	..	1
1918	15,652	4,413	9,306	525	102	1	4	2
1919	15,661	4,509	9,816	482	140	2	5	2
1920	15,900	4,689	10,363	614	167	1	..	..
1921	16,126	4,967	10,121	477	174	4	2	..
1922	16,106	5,186	10,158	506	188			

chance to look over the interior of the shell; in case the fire-tube system as a whole is removable, a complete spare set of tubes is sometimes provided.

As a matter of fact, considerable space in the reports is devoted to the Cornish and Lancashire boilers. Owing to the unequal expansion of the flues and the shell, cracks are often developed in the flanges connecting the former to the front plates, especially if the staying is too rigid or if plain instead of corrugated furnaces are used. In general, oxyacetylene welding has not been reliable, although the results depend very much on good workmanship, so the district engineers recommend electric welding if use cannot be made of the more reliable but often more expensive boilermaker methods.

Although Siemens-Martin steel is almost universally used in the construction of boilers, it sometimes cracks without any apparent cause. Staybolts and tubes of wrought iron are found to be more reliable than those manufactured of open-hearth steel. Blowoff cocks are preferred to valves because the latter are difficult to keep leakproof. Moreover, where a common blowoff line for several boilers is used, blowing off one boiler may lift the valve of another unless a combination of cock and valve is applied.

The application of the hydrostatic test to old boilers is not considered advisable by the authorities, and an investigation as to the quality of the material is preferred.

The majority of boiler explosions was caused by low water conditions, there being no tendency as to time and location. A few years ago a Cornish boiler in a laundry exploded, but in this case no cause could be found. The boiler explosion at Eygelshoven in 1908 was caused by the high phosphor content of the material.

A peculiar accident took place in February, 1924. A sawmill engineer had cleaned one of his boilers and pumped some water into it in order to ascertain the condition of the feed pump and feed line. Unfortunately, the feed water contained natural gas. Probably the gas was liberated out of the water; at least when the engineer entered the boiler with a lighted candle, an explosion followed and he was hurled against the roof of the boiler room and killed.

The table does not attempt to show the number of explosions or ruptures each year, but does list those through which a death or injury resulted either directly or indirectly.

Motors in Pulverized-Fuel Plants

There are differences of opinion as to the type of motors desirable for coal-handling equipment and for pulverized-fuel apparatus, acording to the 1925 report of the National Electric Light Association's Electrical Apparatus Committee. The Cleveland Electric Illuminating Co. and the Milwaukee Electric Railway & Light Co. report satisfactory operation of open motors where they are of the induction type, whereas the Union Electric Light & Power Co., of St. Louis, and the Consolidated Gas & Electric Co. of Baltimore, feel that the inclosed and airtight motor would be more reliable. Practically all users agree that direct-current motors should be of the enclosed type.

When open-type motors are used, it is necessary to blow out the motor with compressed air at frequent intervals and take the motors apart once or twice a year to remove the layer of dust from the rotor. Motors having a large air gap therefore have advantage over the motors with a small air gap. Special precautions should be taken to keep the bearings in first-class condition so that no oil or oil vapor can be drawn into the windings, as a small amount of oil will combine with the coal dust and clog the ventilating ducts. Special mine-type insulation would be preferable for motors for this service.

The question of suitable housings for control equipment for direct-current motors in this class of service is, in the opinion of the committee, of equal importance. It is practically impossible to make a controller tight enough to prevent breathing action which allows very finely divided coal dust to sift in. Two solutions have been proposed. The first is to put the controllers in a separate room which is maintained under a slight air pressure. This is accomplished by a ventilating system which supplies clean air to the room. The second is to connect small vent pipes to the controller housing and maintain a slight pressure within the controller. Either method will eliminate any possibility of coal dust getting into the live parts.

A review of the records of some turbines long in service indicates that the blading material or bucket construction is more often and more severely attacked by erosion than by corrosion, the latter being a secondary action. Corrosion appears always to have been taken care of in the turbine industry by the employment of materials such as are not affected by the materials ordinarily found in steam.

Closed Ventilation Systems for Cooling of Generators*

SEVERAL installations of generators using recirculation of air and surface air coolers are now in reliable operation. It is important that the water be admitted to the cooler before the turbo-generating unit is started, as the windage loss alone is sufficient to produce a rapid increase in air temperature. The vital importance of proper cooling of a generator makes it desirable to provide a temperature alarm that will give warning of excessive air temperature. This can be accomplished either by thermocouple or other elements placed in the air-circulation passages, or by water-flow indicator alarms. A temperature alarm relay has been developed to supplement the temperature indicator now being used in connection with temperature coils embedded in the armature. Such a type of relay could be similarly applied for indicating high temperatures due to some malfunctioning in the circulation system.

The use of condensate for cooling water in surface air coolers seems to be limited to cases where clean, fresh circulating water for the coolers is not available, as it is felt that the economies obtained in conserving the heat due to the losses in the generator do not compensate for the increased complication of piping. In some installations salt water is being used in one-inch tubes, although the manufacturers prefer fresh water using the smaller and more efficient tubes. Companies using condensate for cooling, because clean and fresh water was not available, have reported operation entirely satisfactory.

The use of Inert Gas Versus Air in Closed Cooling Systems

The use of an inert gas in a recirculation system, both because of its value in extinguishing generator fires and in reducing windage losses, has received considerable study. The properties of various possible cooling mediums that are feasible for turbo-generators are of interest:

Nitrogen has approximately the same properties as air. Carbon dioxide, which has a specific heat less than that of air, nevertheless has a specific weight great enough to make the required volume of gas for a given cooling effect about three-quarters that of air. The power required by fans for circulating carbon dioxide is about two-thirds that of air for the same cooling effect.

Hydrogen presents some interesting advantages if the explosion dangers can be eliminated. The important characteristics of hydrogen when compared with air as a cooling medium for large high-speed electrical machines are: Lower density, higher thermal conductivity, higher forced heat convection, practically no damage to insulation by corona, prevention of fire.

The comparative effect on temperature conditions in a machine, of hydrogen versus air, may be summarized as follows:

The practical absence of windage loss when hydrogen is used, results in less heat to be removed from the machine.

The temperature drop required to transmit a given amount of heat from the copper to the iron, through the insulation, will be materially lower in hydrogen. The temperature drop required to transmit heat across the laminations will also be lower in hydrogen than in air.

The temperature drop required to transmit the heat from the surface to the high-velocity ventilation gas will be less in hydrogen than in air.

When the gas reaches the coolers, less temperature difference will be required to remove the heat from hydrogen than from air, and therefore the hydrogen will be lower in temperature when it returns to the generator.

The cumulative effect of all these factors is a considerably lower copper and insulation temperature. This advantage may be used to increase either the life or capacity of the machine according to which seems the most desirable. Tests of a hydrogen-filled machine show that with the same temperature rise 30 per cent greater load could be carried and the efficiency would be more than 1 per cent higher. The reduction of noise was quite noticeable. The whole subject is worthy of further careful study.

Generator Fire-Fighting Equipment

From the reports received for the last two years, it is evident that considerable progress has been made in the application of carbon dioxide in generator fire fighting. The Hartford Electric Light Co., which installed some of this equipment several years ago, is extending the use of CO_2 for such purpose as an insurance against the damage that may result from generator fires.

The Mellon Institute in Pittsburgh has carried on extensive investigations regarding the proportion of CO_2 required to smother a fire comprising burning insulation. These results show that about 20 per cent CO_2 is sufficient to smother such a fire.

Turbo-generator manufacturers have agreed that CO_2 can do no harm to the generators and therefore operators need not have any hesitancy in releasing the carbon dioxide in case of the slightest suspicion of a fire. The cost of such equipment is not large in proportion to the value of the machine protected thereby, and the cost of recharging is low. Because of the favorable comparison of carbon dioxide to air as a circulating medium in closed systems, and its fire-extinguishing qualities in any application, carbon dioxide deserves careful consideration for the various purposes it can serve.

The energy wasted by the loss of heat through ordinary furnace walls ranges from 3 to 15 per cent of the heat in the coal. The latter figure, however, is well beyond the limits of ordinary practice, applying only to small boilers operating at extremely low ratings. The other extreme of 3 per cent occurs only with the largest boilers operating at high ratings. For the average boiler under average operating conditions, this loss is at least 4 per cent. About seven-tenths of this amount can, on the average, be saved by proper insulation of the furnace walls. This increases the boiler over-all efficiency about 3 per cent, but the coal saving is greater than that. For example, suppose that the boiler efficiency is increased from 60 to 63 per cent by proper insulation of the furnace walls. Then $\frac{3}{60}$, or nearly 5 per cent of the coal is saved. With small boilers operating at low ratings, the percentage of coal saved may be considerably more than this.

*Abstract from National Electric Light Association's 1925 Electrical Apparatus Committee's Report.

Generating Units of United States Helium Gas Power Plant

By Z. W. WICKS
Lieutenant-Commander, U. S. Navy

Twin 500-horsepower gas engines supply power for gas compressors. The savings over purchased energy will pay for engines in four years. The engines have novel cylinder-jacket construction.

HELIUM has removed most of the danger attending the use of dirigible air ships through its replacement of the highly explosive hydrogen gas. Only a few years ago helium was considered a gas existing only in the sun. Consequently, the discovery in the natural gas from the Petrolia, Texas, fields of this non-explosive gas gave the United States Government a decided advantage in aviation. While the process of recovery is interesting, to engineers the chief novelty is the exclusive use of gas engines in the helium recovery plant.

The helium production plant was constructed at Ft. Worth, Texas, in 1920 and 1921, deriving gas out of the lines to Ft. Worth and after extracting the helium, recompressing and returning the gas to the pipe lines. In the extraction process the gas is compressed to 3,000 lb. per sq.in. and since high-pressure compressors of 42,000 cu.ft. per hour capacity had not been driven by gas engines, it was deemed desirable to use motor drive and to purchase the electrical energy from the local public utility.

Generating Plant Found Advisable

The government could make only a one-year contract, and the load fluctuated on wide limits from month to month on account of the variation in the flow of helium-bearing natural gas. The electric rate, while reasonable in view of these conditions, proved to be very high on a kilowatt-hour basis. This led to a consideration of a gas-engine plant.

A small amount of low-pressure steam was required, and calculations indicated that the economizers placed in the engine exhaust lines would be able to supply the demand. Still another inducement was the reduction in power required by the plant when driven by gas engines. The gas used by the engines would decrease the amount of gas to be recompressed and delivered back into the gas mains, representing approximately one-eighth of the gas processed.

Based on these considerations, plans were made to install gas engines driving alternators to supply energy to the motor-driven compressors. In order to obtain maximum flexibility and efficiency, 500-hp. units were determined upon, although the estimate of the load requirements totaled 8,000 horsepower.

The power-house building was constructed of material salvaged from the Helium Experimental Station at Petrolia, Tex. A cooling pond was made by damming a small creek that ran through the property. In March, 1924, the first three of the engine generator sets were erected. By December many important improvements to the process of helium extraction had been made, with the result that 3,500 hp. was sufficient to operate the plant at full capacity. In January, 1925, four more units were installed, completing the seven necessary.

Each of the gas-engine units consists of two Bruce-Macbeth four-cylinder 250-hp. engines with a 435-kva. 2,300-volt three-phase 60-cycle alternator placed between the two engines and connected to the shafts by rigid couplings. With a flexible coupling there would be experienced a backlash from one engine to the other, which would probably result in a broken crankshaft in a short time. With the rigid coupling the two machines become, in fact, an eight-in-line engine with the generator interposed between the fourth and fifth cylinders. No difficulty has been experienced in keeping the bearings lined up. Each main bearing has its own alignment pin, and one gage pin fits all bearings so that they can all be brought to the same height. The generator bearings are set with a tram furnished by the manufacturer of the engines, and after a little experience a good mechanic has no difficulty in getting almost perfect alignment.

Engine Auxiliaries

Each engine is fitted with an exhaust economizer, or boiler, which under test has evaporated 2.5 lb. of water from 100 deg. F. to steam at 15 lb. gage per engine brake horsepower output.

The engine-generator units are arranged in two banks, three in the south and four in the north bank. Two 150-kw. motor-generator exciter units with automatic starting equipment are arranged in a side bay on the east side of the building, along with a 25-hp. gas engine belted to an air compressor supplying the starting air, and to an exciter used only when the main exciter is dead, as on starting the plant from idle.

In the north end of the west side bay is the battery of 14 dry positive gas meters, each having a capacity of 5,000 cu.ft. per hour, and a recording calorimeter.

The circulating-water pumps are placed in the pump-house built adjacent to and below the level of the pond. The pumping equipment consists of two motor-driven centrifugal pumps, each capable of delivering 2,000 gal. per min. at a head of 50 lb. per square inch.

The engines, which are of the new Bruce-Macbeth design known as the "Tank" type, have cylinders 14½-in. bore and 17-in. stroke. They are equipped with air-starting valves and mechanism suitably arranged to admit compressed air at 250 lb. pressure to all cylinders for starting purposes. This mechanism is so arranged as to be automatically disconnected after the engine is in operation. The pistons are of the trunk pattern and are fitted with five cast-iron piston rings.

The open tank is a one-piece casting and completely incloses all four cylinders and heads. The intake manifold is placed on one side of the tank near the upper

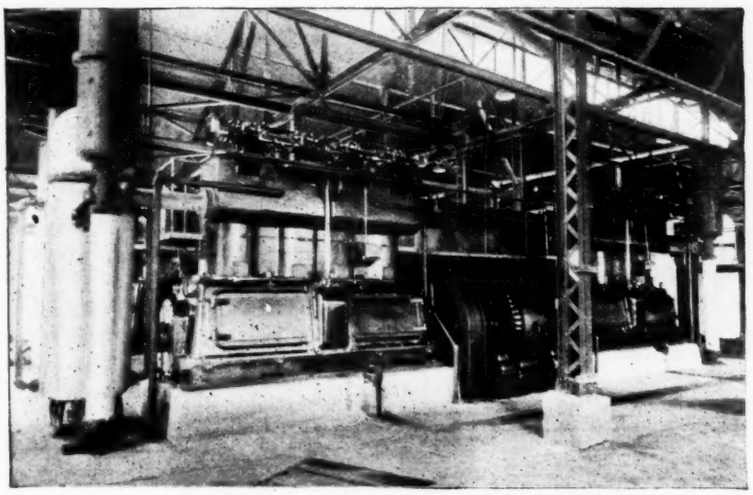


Fig. 1 (Left)—One of the 500-horsepower gas engines with exhaust economizer supplying low-pressure steam

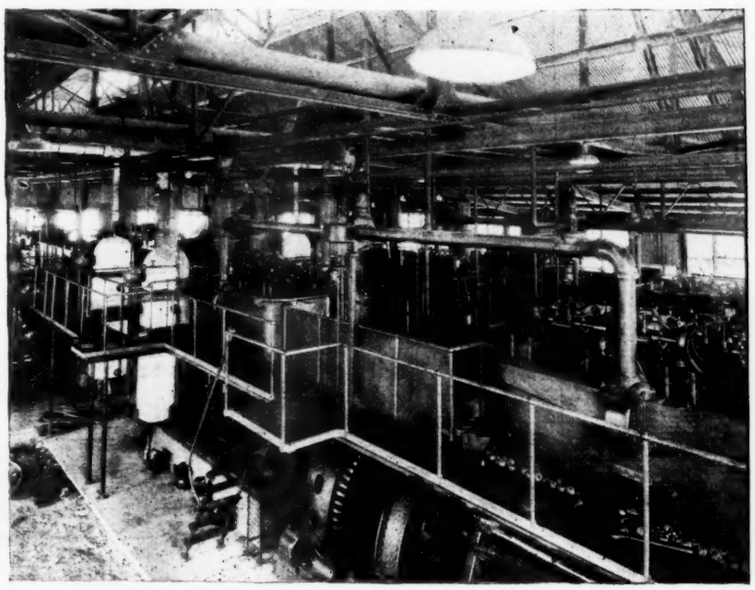


Fig. 2 (Right)—View of the engine room containing seven 500-horsepower natural-gas engines direct connected to generators

Fig. 4 (Below) Emco dry positive gas meters measure gas used. A recording calorimeter is at right of illustration

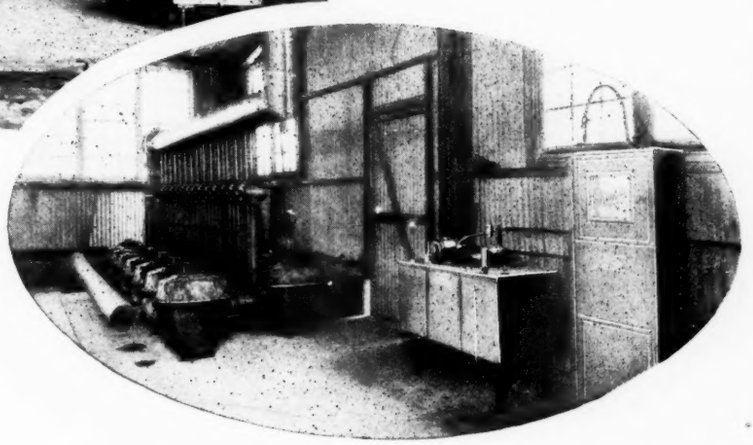


Fig. 3 (Above)—Bay of building contains motor-driven exciter, automatic starting panel and emergency engine-driven exciter

edge. The exhaust manifold passes through the tank near the bottom on the opposite side from the inlet manifold. The cylinders are bolted to the crank chamber through the tank, and a gasket is used to make a watertight joint between the cylinders and tank. The cylinder heads are without water passages, being covered by the tank water. This type of construction was necessitated by bad water conditions existing at this plant, which cause excessive depositing of hard scale. All parts of the engine subject to the formation of this scale are readily accessible and easily cleaned. The same results could have been obtained by using a closed cooling system with water-treating equipment or evaporators, but it is believed that this type of engine construction is the best solution for the local water conditions. At the same time the cylinder and head construction is much simpler and less subject to casting and heat strains.

The lubrication system as worked out for this plant is a modification of the original splash system. The solid splash pins fitted to the crankpin bearing to pick up the oil and throw it on the bearings, were replaced with hollow pins and the lower halves of the bearings were drilled through in the wake of the pins. By using a large plate-glass door in the crank chamber, the best shape and dip of the pins were determined so as to give the maximum lubrication to the crankpins and ample to the cylinders with the minimum agitation of the oil in the crank chamber. Each chamber is fitted with an adjustable overflow so that a fixed oil level is maintained in all compartments, all overflows being piped to an underground tank. From this tank a suction is taken by one of two Viking spur-gear pumps, and the oil is discharged to the oiling system through an oil cooler at a pressure of about 20 lb. per square inch.

Each engine is fitted with four sight-feed oilers into which the oil is discharged and flows directly to the caps of the main bearings. In addition oil thrown by the splash pin is caught in a pan near the top of the crank chamber and flows to the main bearings. The oil in the underground tank is cleaned for about six hours daily by means of a centrifugal purifier, and all new oil is introduced into the system by dumping it into this same tank. Additional cylinder lubrication is obtained by forced-feed lubricators eccentric driven from the camshaft and so timed as to deliver the oil into the space between the first and second piston rings.

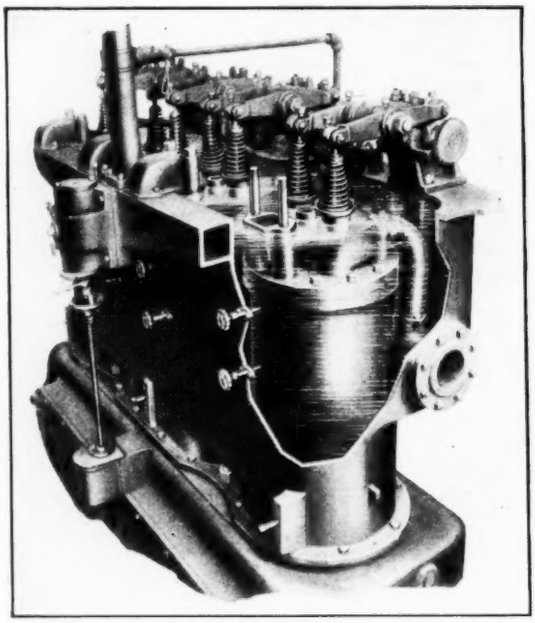


Fig. 5—Cylinder jacket is a cast-iron box, the liners being separate castings

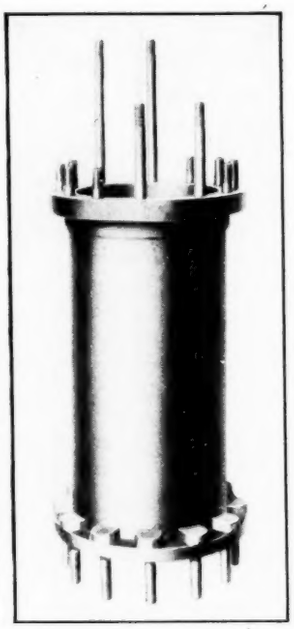


Fig. 6—The cylinder line is a simple tubular casting

Only one mixing valve is used for both engines of a unit, and it is located centrally between them. This assures that all eight cylinders will get the same mixture and each engine will perform its proper share of the work put on the unit. The governor is of the flyball throttling type and controls the mixing valve. While the action of this governor is quite satisfactory, it is believed that more sensitive control of speed and, consequently, of voltage could be obtained if the work on the governor was restricted to the operation of a pilot valve, which in turn would control an oil cylinder actuating the mixing valve.

The panels and switchboards are arranged facing the power units and all rheostats are grouped behind the board. As the panels are set up on the floor level, the view of the synchroscope is blocked from several of the units. In order to facilitate synchronizing the units, two additional synchroscopes have been installed, back to back, well overhead and between the two banks of units so that one of the instruments is visible from any of the mixing valves. In order to encourage better adjustments of the mixing valves and to cut down the time necessary for the enginemen to go from one mixing valve to another, the operating platforms of all engines have been connected by a walkway. The small cost of this walkway has been more than paid for by the better care given the machines.

The operating data for three months are shown in Table I. The rated capacity per unit, including the conversion factor of horsepower to kilowatt-hour, the alternator efficiency and the necessary power to operate the motor-generator exciter unit, the oil pumps, the oil purifier and power-plant lights, is 312.5 net kilowatts delivered at the switchboard. The total output as given in the table is the power consumed in the helium plant outside the power house. It will be observed that the

TABLE I—OPERATING RECORD OF NATURAL GAS ENGINES

Date	February	March	April
Number of units operating	3, 4, 5 & 6	3, 4, 5	3, 4, 5 & 6
Unit-hours operating	2,645	2,785	3,062
Maximum demand, kilowatt-hours	1,775	1,500	2,000
Minimum demand, kilowatt-hours	300	740	800
Average demand, kilowatt-hours	1,220	1,184	1,400
Total output, kilowatt-hours	819,500	881,000	1,008,500
Average load on each, kilowatt-hours	309.8	316.3	309.8
Unit load factor, per cent	99.14	101.22	99.14
Plant load factor, per cent	55.75	54.13	64.03
Total gas consumed, thousand cu.ft.	18,533	20,047	22,800
B.t.u. per cubic foot of gas	700	700	700
Consumption of B.t.u. per kilowatt-hour	15,830	15,928	15,825
Over-all efficiency without economizers	21.57	21.44	21.58
Over-all efficiency including economizers	41.78	41.53	41.80

unit load factor is practically unity for the three months. In order that the average load per unit for the month can be that high, it is clear that the rated capacity as given by the engine builder is very conservative and that the engines are capable of carrying considerable overload. From this same figure it is evident that the selection of engines of this capacity for this particular installation was justified.

Unless one has had actual experience with an efficient exhaust economizer, it will be hard to believe that this part of the installation will bring about the large increase in over-all efficiency as shown in Table I.

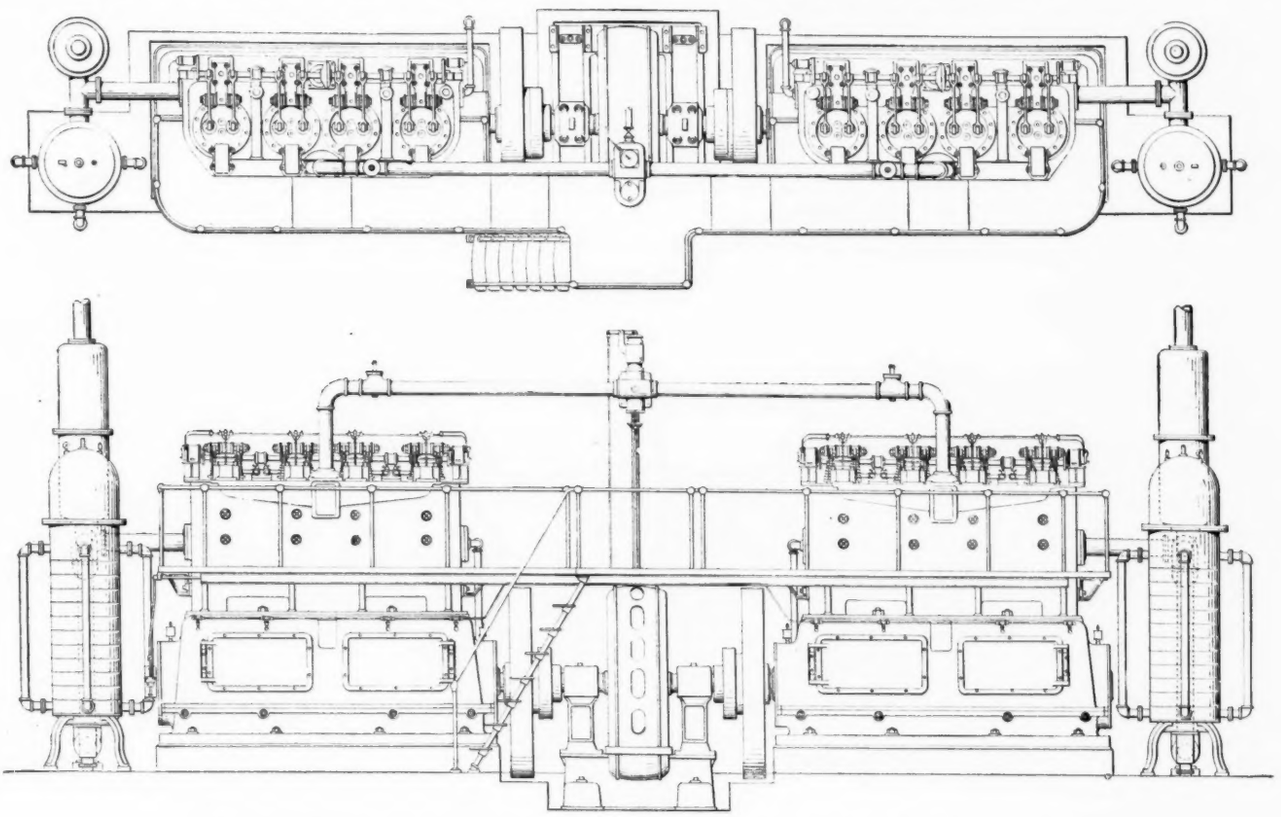


Fig. 7—Arrangement of two engines direct connected to a single generator

Although actual tests have shown that these economizers will produce 2.5 lb. of steam per engine brake horsepower, the following assumptions were made in figuring the over-all efficiency: 2 pounds of water evaporated per engine brake horsepower-hour or 3.2 pounds per kilowatt-hour output of plant, with the feed-water temperature at 100 deg. F.; the steam pressure at 15 lb. per sq.in., the steam being 10 per cent wet.

The over-all efficiency without economizers shown in the table takes into consideration all losses in the engines, all electrical generating losses and all power consumed in operating the power plant itself.

In Table II there is given an analysis of costs for three months in 1925. Three of the power units had been operated for about one year and the other four units for one month prior to Feb. 1. In the labor charge there is included, the full pay for leave of absence granted to all government civil-service employees, a total for the three months of $477.58, or 11¼ per cent of the total labor charged to the operation of the power plant. The cost to purchase power is based on the contract made on July 1, 1924, for the fiscal year 1925, with the boiler-room clause deductions.

The total cost of the power plant, including all equipment and erection thereof, the estimated value of the building, the construction of the 1,500,000 gal. pond, the construction of the water pumphouse and pumps, value of the land occupied by the plant and pond, all gas, water, steam, air and sewerage lines, was in round numbers $360,000. The total saving applicable to the power plant for the three months amounted to $25,123.51, or at the rate of $100,404 per year.

TABLE II—COST OF POWER GENERATION

	February		March		April	
	Total	Per Kw.-Hr.	Total	Per Kw.-Hr.	Total	Per Kw.-Hr.
Operation						
Fuel*	$3,428.61	$0.004184	$3,708.64	$0.004210	$4,217.80	$0.004183
Labor	990.94	.001208	1,107.80	.001257	1,031.28	.001025
Oil†	441.48	.000502	528.02	.000600	522.25	.000519
Maintenance						
Material	139.13	.000171	144.38	.000164	132.94	.000131
Labor	449.48	.000548	360.60	.000409	313.04	.000310
Gross cost	$5,419.64	$0.006613	$5,849.44	$0.006640	$6,217.31	$0.006168
Credit for steam furnished	1,205.00	.001470	1,205.00	.001368	1,205.00	.001195
Net cost	$4,214.64	$0.005143	$4,644.44	$0.005272	$5,012.31	$0.004973
Cost to purchase power	12,424.80	.....	12,822.10	.....	13,748.00	.....
Cost to produce power	4,214.64	.....	4,644.44	.....	5,012.31	.....
Saving	$8,210.16	.....	$8,177.66	.....	$8,735.69	.....

* Fuel used, natural gas, 700 B.t.u. per cu.ft.; cost 18½ c. per M. † Oil used, 750 viscosity at 100 deg. F.; cost 45c. per gallon.

High-Efficiency Pumping Engines*

By Prof. J. C. Dijxhoorn

CAREFUL trials were made at the Lemmer Holland Pumping Works in January, 1923, to ascertain the capacity of the centrifugal pumps that are used to drain part of the polders, or lowlands, of Freesland, and the steam consumption of the driving engines. On the first day the engines were run at 95, 100, and 105 r.p.m. respectively, the lift of the pumps varying from 1 ft. 10¼ in. to 2 ft. ⅜ in. A higher lift would have been more in accordance with the conditions for which the pumps were constructed, but the opportunity of making any trials at higher lifts did not present itself at the time.

The next day, when the steam consumption was measured, the lift of the pumps was still smaller, varying from 1 ft. 5⅛ in. to 1 ft. 7⅛ in. The mean results of two trials, showing only little difference, may be summarized as follows:

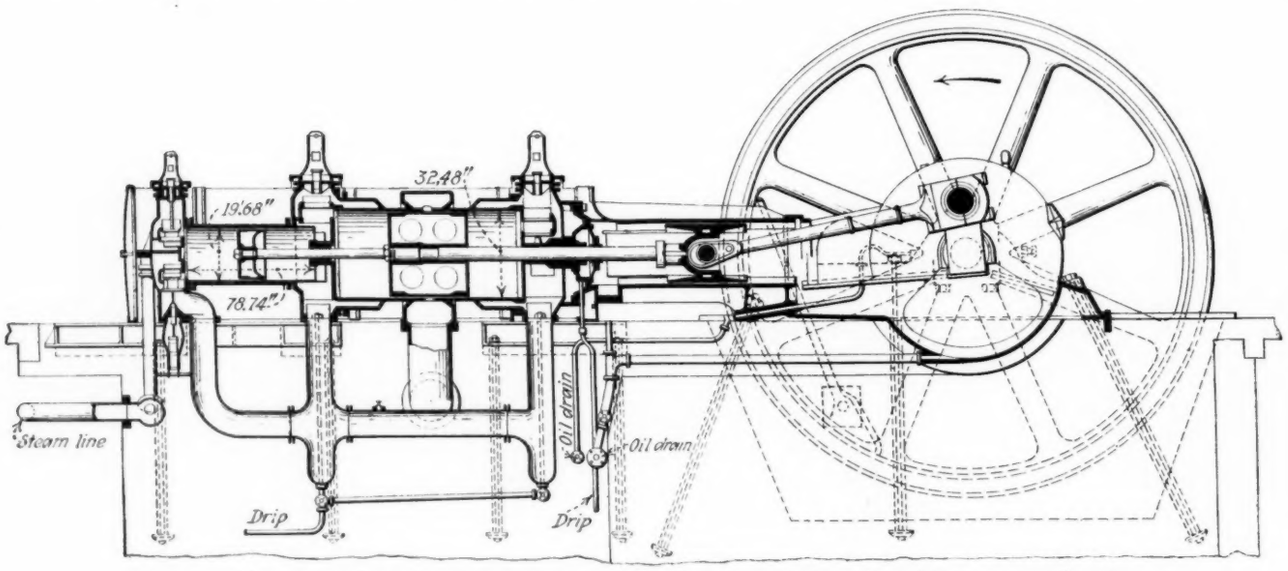
Revolutions per minute	100.15
Mean lift of pumps, in	18⅞
Water discharged per minute, cu.ft.	20,270
Water horsepower of four pumps, driven by two engines	240.9
Indicated horsepower of both engines driving four pumps	876.4
Total efficiency, water horsepower ÷ indicated horsepower	0.275
Steam pressure at the engine stop-valve, lb. per sq.in.	149.6
Steam temperature, deg. F.	589
Mean vacuum in condenser, in. of Hg	28⅛
Total steam consumption of two engines, including condensation in the steam pipe, and consumption of auxiliary pumps for condenser, etc., lb. per hour	8,406
Steam consumption per I.hp.Hr., lb.	9.59

Each main engine has a single-acting high-pressure cylinder and a double-acting low-pressure cylinder, the latter being of the unaflow type. The diameter of the high-pressure cylinder is 19.68 in., that of the low-pressure cylinder 32.48 in., the stroke being 39⅜ in. There are two valves at the rear end of the high-pressure cylinder, one for inlet at the top and one for outlet at the bottom. The low-pressure cylinder has two inlet valves at the top only, the piston itself regulating the central exhaust. There are then only four valves in all, each of the piston type driven from the layshaft which runs alongside the cylinders and which is itself driven by bevel gearing from the crankshaft.

The front end of the high-pressure cylinder is used as a receiver between the cylinders. The outlet valve of this cylinder is virtually an equilibrium valve, and the cylinder, in fact, works according to James Watt's well-known Cornish cycle. In my opinion this combination of the excellent old Cornish cycle for the high-pressure cylinder with the modern unaflow system for the low-pressure cylinder forms a basis for economical working. The indicator diagrams prove that the front end of the high-pressure cylinder practically does not perform any work on the piston at all.

The auxiliary pumps for the condenser are driven by a small horizontal tandem-compound engine running at 160 r.p.m., the crankshaft being directly coupled to the centrifugal circulating pump. The air pump is double-acting and driven from the crosshead.

A high condenser vacuum is considered essential for steam economy, especially in this case, where the low-pressure cylinders of the main engines are built on the unaflow principle. The vacuum varies between 28 in. in summer and 29 in. in winter. The exhaust pipes between the low-pressure cylinder and the condenser are carefully lagged with non-conducting material in order that no steam condensation may take place in the pipes, but exclusively in the condenser. According to my experience it is best to transport the exhaust steam at a mean density as low as possible to secure the smallest difference of absolute pressure between the low-pressure cylinder and the condenser. To obtain a low value of this mean density it is necessary to prevent the formation of water drops in the connection pipes by lagging them with non-conducting material. Another feature which gives the full benefit of high vacuum in the condenser of the low-pressure cylinders is the conical widening of the central exhaust openings of the latter, giving them the form of short De Laval nozzles. By this means the drop of absolute pressure between the low-pressure cylinder and the condenser is only 1½ in., the vacuum in the cylinder amounting virtually to 90 per cent under average circumstances.



Cross-section of Dutch compound steam engine having single-acting high-pressure cylinder

*Extract of paper read before the Institution of Engineers and Shipbuilders in Scotland.

High Sustained Economy in Industrial Plant

By C. J. COLLEY*

In the average industrial plant the refinements of the large central station are not warranted. Load factor, maintenance and economy per dollar invested are the items determining the type of equipment to install. The accompanying data show what may be done in a natural-draft chain-grate plant.

WHEN the engineer of the average-sized industrial plant is called upon to enlarge his power house, he decides that he wants the best and most efficient equipment on the market. Being reasonably intelligent, he knows that it would be poor judgment to ape the central station in selection of equipment, as much of the refinement found here would not be warranted in his case. At the same time his progressive nature impels him to make some substantial advance to insure improved results as compared to those obtained from the old plant.

New Equipment Selected

As an illustration, the Monsanto Chemical Works, owing to increased business, was called upon to enlarge the capacity of one of its boiler rooms. All the boilers in this plant were equipped with natural-draft chain grates and manned by colored labor. Since the old equipment was entirely satisfactory from the viewpoint of sturdiness and dependability, it was imperative, considering the conditions, that the new units be equal to the old in these particulars. After weighing all factors, it was decided to install two 5,630-sq.ft. water-tube boilers with mechanical soot blowers and natural-draft chain grates. Test data collected on the old plant gave convincing evidence that with good designs of boiler baffling and furnace arrangements the equipment selected was best suited to the conditions and the fuel.

As test results from the old plant were quite satisfactory, the main objective for the new units was to improve the monthly average so as to approach or equal these test results. To provide means of checking the performance at all times, boiler meters and CO_2 recorders, in addition to draft gages and flue-gas thermometers, were provided.

Each boiler was erected in a single setting using brick of uniform size throughout. Experience with walls built of uniformly sized brick as well as those having outer walls of regular-sized red brick led to this construction. The general arrangement is shown in Fig. 1. Reversing the boiler would have been preferred, but this was prevented by restricted cleaning space in what is now the rear of the boilers. A reversed setting with this type of baffle probably would have given better circulation and permitted improved furnace design.

The idea behind the furnace design adopted was that of incorporating the advantages of both the vertical and horizontal types of baffling. The vertical baffling for the larger portion of the boiler-heating surface was selected to give the lowest possible stack temperatures. The lower horizontal baffle was decided on to give longer flame travel and larger furnace volume to eliminate smoke, which was important because of municipal restrictions. In the coal as received the volatile hydrocarbon content averages around 35 per cent. With certain Eastern coals having a volatile content in the neighborhood of 15 per cent, a lower setting would have served with this type of baffling.

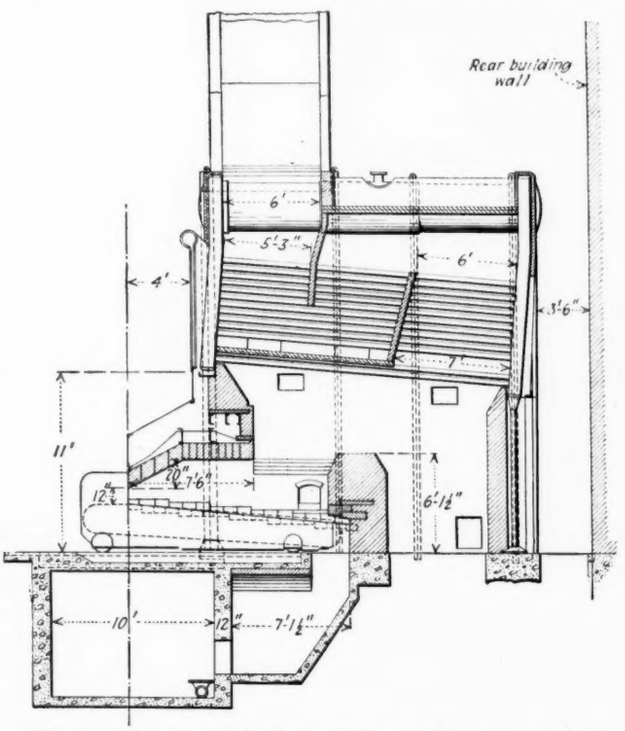


Fig. 1—Design of boiler setting at Monsanto plant

A further consideration was that of slagging. The Illinois screenings used in this plant liberate such quantities of fly ash that at times the entrance to the first pass of the standard three-pass vertical boiler is almost completely slagged over. The horizontal baffle on the third row of tubes provides a slag screen of three rows of tubes, which not only practically eliminates the slagging but also holds down furnace temperatures to the point where furnace maintenance is reduced.

A 90-in. by 185-ft. stack was set up directly between these boilers, giving a short, direct breeching connection. The stack may seem somewhat larger than necessary for two boilers of the size given, but the fact that a load in excess of 225 per cent of rating can be picked up in a remarkably short time, indicates that

*Efficiency engineer, Monsanto Chemical Works, St. Louis.

the dimensions were well chosen. Experience has shown that the ordinary notched damper quadrant did not give sufficiently sensitive draft adjustment, hence a clamp was devised that permits small increments of movement of the damper. Another feature that makes for accurate control of the stoker operation is the individual variable-speed motor drive employed, enabling the fireman to adjust the stoker speed more closely than is possible with straight gear changes.

CO_2 of 12.7 Per Cent Obtained

In operation the boiler meters are set so that by holding the steam-flow and air-flow pens together, 12.7 per cent CO_2 is obtained, with no CO and 38 per cent excess air. When running at 14 per cent CO_2, or 126.5 per cent total air, 0.2 per cent CO was found. Higher CO_2 can easily be obtained, but because of the rapidity with which the loss due to CO increases, it was deemed best to hold to the values given. It must be borne in mind that the adjustment for 138 per cent total air is based on average samples of flue gas taken across the width of the boiler setting to determine the point of sampling for a true average sample. As the results were uniform across the setting, it was evident that no stratification existed.

A value of total air of 138 per cent is somewhat lower than usually can be adjusted for with chain grates, but in this case it is accounted for by the furnace design in which a large active combustion allows the gases to mix thoroughly and then burn out completely before entering the tube nest.

Waterbacks were not installed, but because of the high ratings obtained it is believed that they would be an advantage. However, the loss to the ashpit through unburned carbon rarely reaches 3 per cent, as shown by sampling and weighing all the refuse. This is good performance considering that a 7-in. fuel bed is carried. It has been found of decided advantage in obtaining quick ignition and hence low ashpit loss, to dampen the coal somewhat before firing.

The fuel used is Illinois screenings averaging 11,200 B.t.u. per lb. and containing about 10 per cent ash. The cost of this coal delivered to the boiler room is about $3.30 per ton. The cost of steam per 1,000 lb. for fuel only, averages 20c. and for fuel and labor 24c. We expect to reduce the labor cost by the installation of coal bunkers and a weigh larry. At present the coal is shoveled from the floor into the stoker hoppers.

BOILER OPERATION REPORT

Plant ..... Month .....

1.	Total coal used	Lb.
2.	Total steam generated	Lb.
3.	Steam generated per lb. of coal (Actual)	Lb.
4.	Average steam pressure	Lb.
5.	Average temperature of feed water	Deg. F.
6.	Factor of evaporation	
7.	Total boiler hp. developed	
8.	Lb. of coal per boiler hp.	Lb.
9.	Steam generated per lb. of coal (F. and A. 212 deg. F.)	Lb.
10.	Total cost of coal per ton (Boiler Room)	
11.	Total cost of coal used	
12.	Average heating value of coal	B.t.u.
13.	Cost per 1,000 of steam (fuel only)	
14.	Cost of firing labor	
15.	Cost per 1,000 of steam (fuel and labor)	
16.	Efficiency of boiler and furnace	Per Cent
17.	Average boiler rating (Saturday and Sunday not included.)	Per Cent

Note: No. 7—A boiler horsepower taken as 34.5 lb. F. and A. 212 deg. F.

Remarks:

Date ..... Signed .....

Fig. 3—Boiler-operation report

COAL AND ASH REPORT

Plant ..... Month .....

Quantities of coal ..... Storage ..... Boiler Room ..... Total Tons.....

On hand first of month

Received

Used from

Balance last of month

COAL ANALYSIS AS RECEIVED

Mine	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
Coal Average						

ASH PIT REFUSE ANALYSIS

Dry Ash	Combustible	Ash in Coal	Fuel Loss %
Refuse Average			

Remarks:

Signed

Fig. 2—Coal and ash report

The boiler and stoker efficiency has averaged 75 per cent over a period of several months, as determined by the total coal consumed and the total water fed to the boilers. The water measurements are made with a recording Venturi meter and checked by a recording steam-flow meter. This efficiency is maintained over the full monthly period because the equipment enables us to maintain operating conditions at all times near to those obtained on test.

Fig. 2 shows the monthly coal and ash report sheet. The ashpit refuse is sampled and analyzed, but it has been found almost impossible to get a representative sample. Therefore, in addition all refuse is weighed and this weight used in calculating the monthly heat balance. Ten coal analyses are made per month on samples that are composites of all coal received.

Fig. 3 shows the monthly boiler operation report, which has been made as simple as possible without containing any duplication of the information shown on meter charts.

This plant consumes about $120,000 worth of coal a year, but without the use of instruments we are positive it would be much higher. Given the best and most modern equipment available, the firemen cannot control combustion by guesswork. Granted that some firemen, owing to years of experience, are good gues-

sers, yet the plant that is without instruments has nothing to show that the guessing average for the twenty-four hours is as high as it should be.

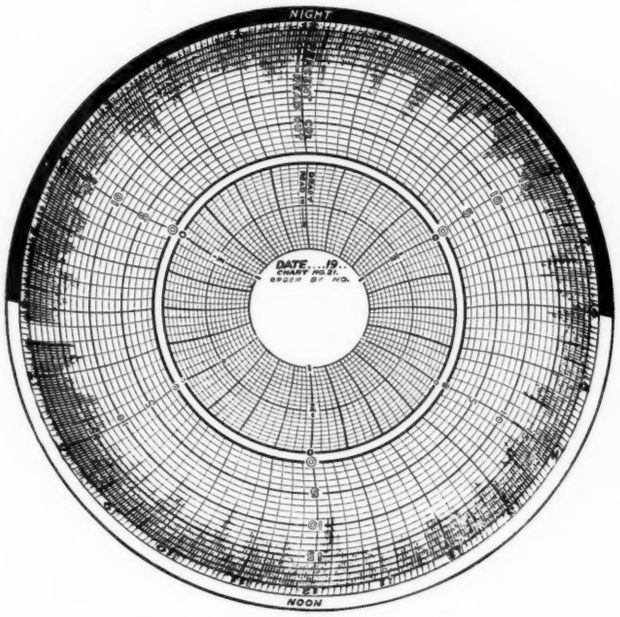


Fig. 4—Typical daily CO_2 record

MECHANICAL EQUIPMENT IN PLANT OF MONSANTO CHEMICAL WORKS

Boilers, h.w.t., 5,630 sq.ft.	Edge Moor Iron Works
Stokers, natural-draft, chain-grate, 137 sq.ft.	Laclede Stoker Co.
Soot blowers	Bayer Company
Feed-water heater, open type	Cochrane Corp.
Reheater, closed type	Standard Water Co.
Feed pumps, cent., 200 gal. per min.	Dayton-Dowd Co.
Meters	Bailey Meter Co.
CO_2 recorders	Jos. W. Hays, Corp.
Venturi feed-water meter	Builders Iron Works
Steam gages, indicating and recording	Bristol Company
Draft gages, indicating	Defender Auto. Regulator Co.

Oil-Engine Bearings

The bearings of the modern oil engine are made up of babbitt-lined semicircular shells. These shells rest in housings formed in the engine frame. It is the practice to bore all the housings on a horizontal boring mill at one setting, followed by a checking on a special fixture. The work is usually performed in a painstaking manner, and although it is seldom that any housing shows more than a few ten-thousandths inch out of alignment, each one is filed and scraped until it tests true. The bearing shells are all made of equal thickness and, after being bedded in the housings, are checked for alignment by a test shaft. If any error appears, it is corrected by scraping the babbitt. After the engine is installed in a power plant, the bearings begin to wear. Since the babbitt linings in the several bearings are never of equal density, the wear is not uniform.

Varying pressures in the engine cylinders tend to increase the discrepancy in the rate of bearing attrition. If the flywheel weight is supported or partly supported by one of the end main bearings, this bearing will probably show a more rapid wear than the others. Oil-engine operators should recognize these facts and take proper steps to maintain the bearing alignment.

Too many allow matters to drift until one or more bearings start to run hot. In most instances it is then too late to save the babbitt lining. Just as there should be a regular schedule in grinding valves and pulling pistons, the engineer should test the bearings at stated intervals.

To remove the bottom half of the bearing, it is necessary only to lift off the top half and turn the flywheel. The revolving shaft will draw the lower bearing from the housing. The thickness of the shell should be measured at both ends and at the center; several measurements should be taken at various points. If these measurements are the same, it is evident that the wear on the particular bearing has been uniform. If the measurements check with readings taken on the other bearings, the main bearings are in alignment. If one bearing shows that it is low, the engineer must decide his course of action. It is possible to shim up under this low bearing until it is as high as the other. If the difference is marked, this is the best procedure; sheet steel makes the best liners. If the variation is less than 0.005 in. the best process is to scrape the other bearings, removing an amount of babbitt to compensate for the variation between the highest and lowest bearings. In cases where all the bearings vary, scraping is the only remedy.

Report of Macy's Power Plant for the Year 1924

Since publication in the June 9 issue of the saving made by the R. H. Macy & Co. department store in New York City, from operating its own power plant, there have been a number of requests for further details as to how this saving was arrived at. The following is a copy of the report:

Total fuel oil burned (1924)	2,870,373 gallons
Total kilowatts produced (1924)	7,535,933 kw.-hr.
Steam supplied to heating	40,000,000 pounds
Steam supplied to ventilation	25,000,000 pounds
Steam supplied to hot-water heating	13,000,000 pounds
Steam supplied to feed-water heating (Bldg.)	7,000,000 pounds
Steam supplied to kitchen and laundry	13,000,000 pounds
Steam supplied to miscellaneous units	10,000,000 pounds
Cost of fuel oil burned	$121,879.25
Cost of lubricants, wastes, etc	6,281.00
Cost of repairs and expenditures	7,162.49
Cost of rental charges for floor space	11,252.15
Cost of salaries of generating plant	15,960.00
Macy's power-plant total cost of operation	$162,534.99
Commercial Values of Service:	
75,000 kw.-hr. @ 5c. per kw	$3,750.00
100,000 kw.-hr. @ 4c. per kw	4,000.00
150,000 kw.-hr. @ 3c. per kw	4,500.00
775,000 kw.-hr. @ 2½c. per kw	19,375.00
6,435,933 kw.-hr. @ 2c per kw	128,718.66
Coal adjustment @ $0.0032 per kw	24,114.98
Total cost if power were purchased	$184,458.64
40,000,000 lb. steam @ 80c. per 1,000 lb.	$32,000.00
25,000,000 lb. steam @ 80c. per 1,000 lb.	20,000.00
13,000,000 lb. steam @ 80c. per 1,000 lb.	10,400.00
7,000,000 lb. steam @ 80c. per 1,000 lb.	5,600.00
13,000,000 lb. steam @ 80c. per 1,000 lb.	10,400.00
10,000,000 lb. steam @ 80c. per 1,000 lb.	8,000.00
Total cost of steam if purchased	$86,400.00
Total cost of power and steam	$270,858.64
Macy's power-plant cost of same service	162,534.99
Total power-plant saving over purchased service	$108,323.65

The salaries referred to in this report are those of employees that could be dispensed with if the plant were shut down. The item "Steam supplied to ventilation" is that used to heat the air for ventilating purposes during the heating season. In addition to this, steam is also used to heat the buildings by direct radiation. The figures do not include any credit for the economizer in the incinerator, which was put into operation a few months ago and has resulted in a fuel saving of about 500 gal. of oil a day, which at the present rate is equivalent to about $7,500 a year.

Developments of the Electric Light and Power Industry 1920-1930

By DAVID COWAN

IN DETERMINING the cause for the phenomenal development of the electric light and power industry during the period 1920-1930 we must fully appreciate that a large proportion of such progress has been due to far-reaching engineering achievements attained during this period. It would indeed be interesting to speculate on the reason for the extremely rapid yearly increase in the efficiency and economy in the methods of producing electric power. Whether we ascribe it to the insistent demand of the plant owner upon the engineer for more and lower cost power or whether the engineer has been the leader in the field and the owner the beneficiary matters little. The fact remains that improvements on the technical side have been definite in their tendency always toward increased magnitude of equipment in general, with a view to more economical operation.

Substantially the greater part of the electrical energy generated by central stations has, in the United States, continued to be furnished by the steam power plant. Although rapid progress has been made in the intensive development of water powers during the same period, the steam power plant still leads in output.

Steam-electric plants have steadily progressed in point of size, and whereas ten years ago a 165,000-kw. station was considered a large installation, there are stations completed within the past three years for a capacity of over 600,000 kw.[1] In considering size of individual generating units it is interesting to note that increases in the kilowatt capacity occurred chiefly during the period from 1920-1924, when in four years' time the limit of generating unit size grew from 35,000 kw. to 60,000 kw. The last four years have not been productive of so many changes in this field, as it has been found that size is not of itself the most important feature, the choice rather depending upon the special problems met with in each station, where in some cases the largest generating unit is not always productive of the greatest economy.

The use of various appliances for utilizing the waste heat losses and the use of high pressure and high temperature steam, operating in so-called reheating and regenerative heat cycles, have resulted in increased over-all thermal efficiencies far above those obtainable without these refinements. In 1923 the average large generating plant turned out a kilowatt on 2.4 lb. of coal as compared with 3.2 lb. in 1920. The most efficient plants in 1924 reduced this figure to 1.3 lb., while present-day plants have obtained a kilowatt on 1 lb. of coal. Further large economies have been instituted during the decade by fuller advantage being taken of such thermal systems of operation as stage-bleeding, reheating and utilization of heat in the waste gases.

Steam boilers have had a more diversified development than any other section of the plant. Steam pressures which in 1920 averaged 300 to 350 lb. per square inch, by 1925 had increased to 550 and 600 lb., with one or two instances of what could then be termed experimental installations operating commercially at 1,200 lb. per square inch, notably in the Weymouth station of the Edison Electric Illuminating Company of Boston. The efficient results obtained from these first installations, establishing the economies theoretically to be gained from high pressures and temperatures, account for the number of plants today operating at from 600 to 1,000 lb. per square inch pressure. The theoretical economies claimed for plants operating on the Benson superpressure or the Emmett mercury steam principle have been put to test in certain experimental plants, but the general adoption of these systems awaits actual proof of heat economy as against increased cost of installation and reliability of operation. It may be of interest here to remark that although the design of materials has kept pace with steam pressures, the limit of temperature appears to have been reached for metals at present available.

The greatest single item of expense in the production of steam power is necessarily the cost of fuel, and engineering talent has been specially directed toward the design of fuel and labor-saving equipment. Among the natural solid fuels coal has continued to be the leader, although we must note that the firing of coal in powdered form has largely supplanted stoker firing

EXCERPTS from paper awarded first prize of $5,000 in the recent contest conducted by Bonbright & Company for the best combined review and forecast of the electric light and power industry for the decade 1920 to 1930. As previously announced, the author is but 21 years old and at present engaged in the insurance business. Second prize was won by R. M. Davis, statistical editor of *Electrical World*, and third prize by John Dockendorf, of Milwaukee. Over four hundred papers were submitted and twenty-one minor awards were made.

[1] The reader should bear in mind that the author is writing as if in 1930.

for large plants burning low-grade bituminous coal, anthracite culm and lignite. Where load factor is very low and stand-by losses correspondingly high, powdered fuel has offered advantages over stoker firing. A number of isolated plants, favorably located, have combined the burning of powdered coal with blast furnace gas. The mechanical stoker, however, still continues to hold its own, especially in the burning of good-grade bituminous coal, anthracite and coke breeze, while the assistance of properly designed furnaces, with ventilated walls and preheated air, has given results very close to those attributed to powdered coal.

Diesel type engines using oil, though requiring less fuel than any other type of prime mover, have not been installed in America for large central stations. This is partly due to the comparatively low capacity of even the largest units and the consequent necessity for greater space requirements to permit of the installation of a number of such prime movers.

Although in the U.S.A. political discussions may be considered to have retarded a more thorough exploitation of water powers, developments in this field have paralleled the improvements in design and construction observed for steam plants. The progress so made may be observed by noting that whereas in 1920 the total kilovolt-ampere generator rating for the United States was 5,628,000, this figure has since grown to about 11,500,000 kva. as at present. This progress has been continuous throughout the period, the total rating of hydro-electric generators in the United States for 1925 having been 8,093,000 kva.

Here it might be interposed that in Canada it is well known that the hydro-electric station has been consistently the leader in the past ten years for the production of power. There were in 1920, 2,500,000 hp. of waterwheel and turbine installations, the increase being continuous to 4,000,000 hp. in 1925 up to the present figure of 5,200,000 hp.

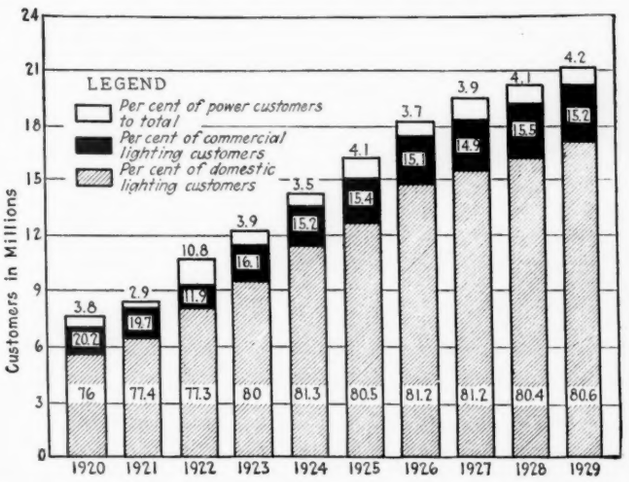
Average capacity of generator units has similarly traveled in an upward direction from the 30,000-hp. machines constructed in 1920 to the 70,000-hp. wheels installed in the Niagara Falls Company's plant in 1925. Changes since that date have been far less rapid, as activities have been confined to the study of economies to be gained from such installations, which at that time were considered to be more or less experimental in nature. A special study of draft-tube design has, moreover, developed an ejector type which maintains the output at normal rating during the flood season when the effective head is reduced.

Reference should here be made to the increased use of electric boilers and the large capacity of some of the units now in operation. In the case of industries or heating plants located close to abundant water power, it has been found economical to use off-peak power to generate heating or process steam from hydro-electric power in specially constructed boilers.

Lower Power Costs

One cannot read of great technical achievements to lower power costs without concluding that an even greater centralization of power generation has been a feature of the past decade. The effect of this tendency on the individual industrial power house is interesting to examine, for the isolated unit has in fact always constituted a peculiar problem in utility engineering. While one has already noted the ever-increasing size of central-station equipment, with attendant reduction in generating costs, and with savings in transmission and distribution, the habitual small average capacity of the isolated unit has necessarily precluded the incorporation of the larger part of these refinements in power production methods as they were devised.

Cheaper power rates have undoubtedly encouraged the further use of central-station energy by large industrial consumers, especially during the last five years, but it would be wrong to gain the impression that the tendency has been toward a complete disappearance of the isolated unit as an adjunct of American industry. True, where requirements have been for 500 hp. or thereabouts, it has undoubtedly been practical for plants to use central-station energy where such is available at usual rates. On the other hand, it is well to note that factories requiring 500 hp. or more have in many cases found it economical to retain their own stations, even though maintaining connected lines from central



TOTAL CUSTOMERS OF CENTRAL-STATION COMPANIES, 1920-1930

systems for exigencies of load irregularities. Especially has this practice been true in the case of industries where steam must be employed for certain processes and operations.

Growth of Super-Power

The first localities to be successfully covered by a super-power system were those where large companies already operating in an extensive field without competition—in many cases the less densely populated but rapidly expanding sections of the country. Thus the South and West, by the close of 1924, each possessed a super-power system similar in practically all respects to that existing today, for at that time the interconnecting of four or five large units immediately resulted in a network of distribution extending over hundreds of square miles. The zones in the Middle West (apart from the Commonwealth Edison's and other Insull properties' power pool, which was established very early in the decade, but may now be considered as then relatively local in scope) and on the Atlantic seaboard have been of more recent accomplishment, owing largely to the number of independent plants in thickly populated sections that required to be amalgamated or merged with existing corporations, before large-scale interconnection could be possible on a profitable basis.

As to the former, one can only briefly state that the best results have been obtained where it has been the policy to retain existing hydro-electric and steam stations, whenever possible, and mold them into integrated

units instead of constructing large new stations to supplant these.

As mentioned in the concluding remarks of the preceding discussion, the rapid expansion in the amount of business transacted by central stations has been one of the outstanding features of the past ten years. In attempting to explain the reasons for this stupendous growth, as indicated by the accompanying chart, one should remember that not only will this year's census show some 15,000,000 people added to the population of the country since 1920, but consumption per capita has also greatly increased. In addition, the utilization in industrial plants of power generated from central stations has mounted far more rapidly than suggested by the mere growth in the number of customers.

AMOUNT OF ENERGY GENERATED IN THE UNITED STATES

(By central electric light and power stations, by plants of electric railway companies, and certain other systems not classed by Census Bureau as central stations)

	Kilowatt-Hours		Kilowatt-Hours
1929	89,280,000,000	1924	58,996,000,000
1928	83,863,000,000	1923	55,674,000,000
1927	76,325,000,000	1922	47,659,000,000
1926	69,250,000,000	1921	40,976,000,000
1925	64,750,000,000	1920	43,550,000,000

No less striking has been the increased use of electricity in agricultural communities, and especially is this remarkable in the case of Pacific Coast States. This field has continued to form an exploitable market for power until at present, in California, to cite one instance, over 20 per cent of electrical energy generated is used for agricultural purposes, irrigation and so forth

Administration and Financial Development

The vast developments and extensions that have occurred in that period under review, as emphasized in the preceding sections, must lead one to conclude that problems confronting public utilities have not been solely technical in character but have necessarily included administrative and financial problems as well. An industry cannot show a ten years' increase in gross revenue from $882,750,000, as in 1920, to close to $2,000,000 in 1929, and a growth in capital investment from $4,100,000,000 to $9,700,000,000 within the same period without having necessitated a considerable number of changes, both corporate and financial.

Such has indeed been the case, and in the search for economic methods of operation probably the most important feature was the early manifestation of a definite and well-marked tendency toward financial consolidation. This factor has, moreover, arisen as a natural outcome of the long-recognized principle that local monopoly is the only basis on which a public utility can economically operate. As engineering achievements during the first three or four years of the decade made the scope of operations of the central station an ever wider one, it became necessary in following the above policy to consolidate or amalgamate, as the case might be, a number of hitherto independent operating companies.

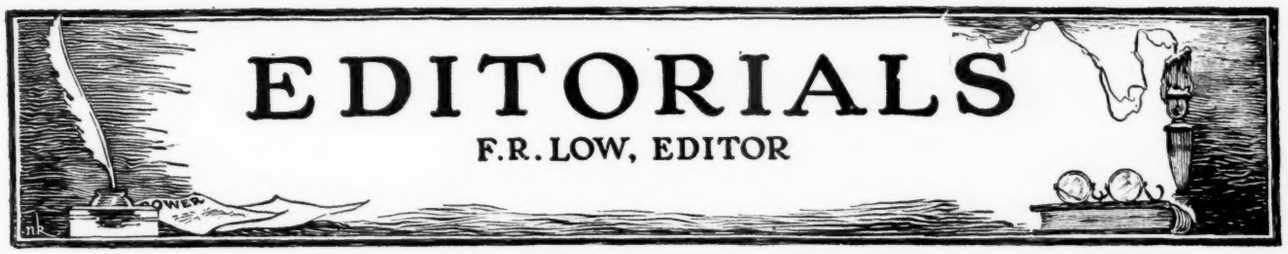
The past decade, moreover, if not giving birth to, has at least caused a great impetus to be given to, the formation of so-called "holding companies." The latter has indeed been a much misunderstood term, owing largely to a lack of appreciation of their function as bankers, in many ways, to the electric light and power industry. These holding companies showed tremendous expansion during the years 1920-1925, a period which was remarkable for the number of independent operating companies which passed to their control. The growth to tremendous size of such holding or investment companies as the American Gas & Electric, the Columbia Gas & Electric, the United Light & Power and many others, although founded many years ago, can be accepted in a large degree as a feature of the past ten years.

It would be a refusal to face actual problems were one not to admit that such "delocalizing" of the industry, especially as of recent years, having caused the electric light and power corporation to resemble the railroad in capital and executive structure, has produced grounds of discontent on the part of certain communities. These maintain, among other things, that the investment company has enriched itself at the expense of the public by gains arising from swollen market values, from underwriting and trading profits, or from the collection of excessive dividends from operating companies. It is, moreover, felt that better relations could be had with the public if the control and management of the local utility rested entirely within the community served. Whatever viewpoint be taken, there is undeniable proof, however, that the holding company has been a decidedly constructive factor in the development of the industry. It has continued to facilitate the provision of excellent service to increasingly large numbers of small towns and communities—a service unobtainable in any other way—while investments by bankers in certain enterprises would never have materialized but for the holding companies back of them.

Public Relations and National Problems Arising from Electric Light and Power Developments in the Past Ten Years

Agitation for government ownership, once quite menacing, has very largely disappeared. People have come to realize that utilities have now largely become public property through the simple method of stock purchases by thousands of customers and employees. In fact, customer ownership has been an extremely important factor in the successful growth of the electric light and power company, for not only has it enlisted the services and good will of the various communities served, but has, moreover, constituted valuable equities behind the bond investments of bankers and financial institutions—the early sponsors of the industry. A reassuring sign for the future has been the creation of a special "public relations" department by utility corporations, as was done some five years ago by the Public Service Corporation of Northern Illinois.

The question of equitable rates has always been to the forefront among the problems of public utility administration. During the first few years of the decade, however, the generosity of corporations in continuing to lower the price to consumers in the face of higher commodity prices had the effect of disarming the customary critic of exorbitant charges. In the past two or three years, however, rate decreases have been much less frequent, because the industry has come to realize that, under a more normal basis of operation, it would be inadvisable to lower the margin of profits to such an extent as to be seriously handicapped by an unforeseen contingency. Permission to lower rates is always readily granted, but the turbulent history of electric transactions indicates, if anything, that sanction to increase rates is quite a different matter, even when economically justified.



Enforced Boiler Inspection

MANY of the European countries are of such size that it is easy to carry out procedures impossible in a country of broad boundaries. Consequently, the enforced inspection of boilers by state agencies is well established in such countries as Holland. On page 6 appears a discussion of the inspection requirements and a tabulation of the number of yearly inspections, tube renewals and accidents since the establishment of the inspection bureau.

With approximately twenty-one thousand pressure vessels the list of but four deaths and two cases of serious injury in two years indicates that while boilers sometimes explode in spite of inspection, nevertheless, nation-wide inspection has promoted safety. In this country, where thousands of boilers are operated without internal inspections, the number of deaths and accidents undoubtedly bears a greater ratio to the number of boilers than in Holland. Only when rigid inspection is carried on are explosions a rarity.

While data on the number of deaths and injuries caused by boiler explosions are lacking, apparently boilers inspected by insurance companies show as good a record as those in Holland. The Hartford Steam Boiler Inspection & Insurance Company last year had approximately one hundred and twenty-five thousand power boilers under insurance, and there were three hundred cases of boiler trouble listed as explosions. The majority of these were minor, consisting of tube ruptures and collapses ordinarily not considered as true explosions. The number of personal injuries and deaths is not known, but probably is a no greater percentage than shown in the Holland tabulation.

The Power Plant as a Machine

THERE is a decided tendency in power generation and distribution to make the operations as nearly automatic as possible and to eliminate the human element, just as in other manufacturing processes. Making a steam plant automatic in its operation to the extent that the key can be turned in the door and the station left in operation for days at a time without attention from anyone, is something that is too much of a dream to be even considered. Neither is there apparently any good reason for such a plant as there is for automatic substations and hydro-electric stations. However, there are sound economic facts for making the various functions of the steam plant as nearly automatic as possible. On the electrical end of the modern station this has been done to a high degree and the control concentrated at a central point so as to be directly under the direction of a responsible operator. The chief function of this operator is not to control the equipment, but to see that it responds properly to the automatic control and make such minor adjustments as are necessary for the most economical operation of the plant, and to keep a record of performance.

Unfortunately, the boiler end of the plant has not been favored with any such centralized automatic control as has been the case with the electrical generating, except very recently, when there has developed a tendency in this direction in the large plants. Owing to a lack of such centralized control the average boiler plant is operating considerably below the efficiency it should attain.

Centralized automatic boiler control has been developed to the point and experience has shown that it is capable of maintaining the boiler plant operating at test conditions. It has made possible the control of the plant directly under a responsible combustion engineer, relieved the attendants of the responsibility of the plant responding to load conditions, and left them free to look after the details incident to change in quality of fuel, condition of the fires and the like. In short it has made the boiler plant a machine actuated from a single master control which makes all units respond to the same impulse instead of each individual unit acting more or less independently and requiring constant attention to make it do its share of the work. The nearer the power plant can be made a machine the nearer it may be expected to approach ideal operation. This should not relieve the operator of any responsibility, but give him a greater opportunity to keep every part of the equipment adjusted to render as nearly as possible one hundred per cent service.

Checking the Performance of Small Turbines

THE man in charge of an industrial plant may be just as desirous of obtaining economical operation as one in a large and more highly organized station, but seldom is given equal facilities for checking the turbine water rate. If a main unit is a five-hundred-kilowatt turbine and it appears to be using too much steam, an accurate test may be prohibitive on account of the expense of special equipment and trained men from without the organization. With larger units, however, trained assistance is frequently near at hand as well as the necessary paraphernalia. Continuous testing of fair accuracy may be part of the operating routine.

In operating small machines, the problem hinges more directly on detecting and proving uneconomical operation by means other than accurately measuring the steam and load. In most plants the amount of coal or steam required to produce a kilowatt is determined at regular intervals. A serious falling off in prime-mover economy will eventually become evident, depending on the closeness with which the operation is checked. Where water rates have seriously increased, the condition may become apparent to the operator by other means, such as the turbine valve gear admitting

more steam and thus assuming a greater degree of valve opening than originally for the same load, steam and exhaust conditions. Less load will be carried at a given speed if in multiple with a unit in the same condition as originally. Checking is more difficult where non-condensing turbines drive machines such as pumps, fans, etc.

In addition to these approximate methods of gaging economy, an accurate means is readily available provided that the load can be measured without great inconvenience. Each stage of a turbine is in a way a steam meter. The pressure of the steam supplied is an index of the amount passing through. Variation of a stage pressure at a known load indicates a change of internal condition and a loss of economy, provided steam and exhaust pressures are maintained the same.

Stage pressures, therefore, at loads that may be easily reproduced, should be recorded from time to time. For a single- or two-stage turbine the inlet pressure between the governing valve and nozzle is sufficient. Data as to the proper stage pressures may be taken directly on a new unit, or if originally neglected, may be obtained from the manufacturer. The load pulled by a pump or fan can often be repeated with sufficient accuracy. Therefore a reliable means of reproducing operating conditions and accurately gaging internal pressures are practically all that are necessary for checking the relative steam economy of a turbine.

Another Milestone in Hydro-Electric Development

ALTHOUGH there has been practically a revolution in the design of steam plants toward improved efficiency during recent years, water-power plants have been able, even under adverse circumstances, to compete with power generated in steam-electric plants. This is well exemplified in the leading article in this issue, which describes a plant that is to operate under a net effective head of seven feet, and is situated in one of the large coal-producing states.

Just what such a low head means in the construction of a hydro-electric plant is probably best illustrated by a comparison with a plant operating at medium head using the same type of wheel. In the Great Falls plant of the Manitoba Power Company, twenty-eight thousand horsepower units operating under a fifty-six foot head are set on fifty-seven foot centers. For the seven-foot head plant, where the wheel develops only eight hundred horsepower, they are set on forty-eight foot centers. With only nine feet difference in the longitudinal space taken up by the two different units, one develops thirty-five times as much power as the other. Although comparative costs per horsepower do not run in any such proportions, these dimensions and ratings indicate that if low-head water-power plants are to be made economical undertakings, they must be so designed as to keep the cost at a minimum consistent with reliable operation.

Without the modern high-speed type of runner which has been developed in a number of forms during the last few years, such a plant as referred to would be practically impossible, at least using vertical-type machines. One of the outstanding features of the design is that, although handicapped by an extremely low head, there have been incorporated all the desirable features of a medium-head plant such as vertical-shaft machines, accessibility for inspection and modern type draft tubes.

The co-operation between the two groups of interest in the project is by no means a minor part of this development, since such co-operation is necessary for the redevelopment of many of our uneconomically developed water powers. With the old arrangement less than one-quarter the water was utilized in two plants as is now used in one station, which has capacity for producing over five times the amount of power, with provision for further increasing the capacity when conditions warrant the installation. Based on one and one-half pounds of coal per kilowatt-hour the yearly output of the plant is equivalent to that requiring the burning of ten thousand tons of coal. The most of the water would still be running to waste if those who owned the water right had not agreed to pool their interests. This plant, laid out for a maximum capacity of fifty-six hundred horsepower, has established another milestone in hydro-electric development and has much to recommend it to the attention of those interested in making the best use of our water powers.

The Place of English and Economics in Engineering Education

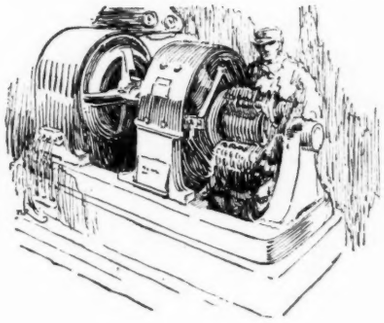
IN SPONSORING a far-reaching investigation of engineering education in its every aspect, the Society for the Promotion of Engineering Education is rendering a real service to industry, to future engineers and to the public at large. At the recent annual meeting in Schenectady, where the papers and discussions centered largely around the information obtained in a preliminary survey, the attention of engineering teachers, practicing engineers and industrialists was directed to facts and problems of considerable importance. Some of these problems were discussed editorially in last week's issue.

Another interesting fact brought out was the generally existing difference of opinion between practicing engineers and undergraduates as to the value of certain subjects in the curriculum. The average technical student is inclined to be impatient of such studies as English and economics. To him they seem to be of little practical value, wasting time that he might more profitably devote to strictly engineering studies or even to recreation.

Often this impression is confirmed by the experience of his first job after graduation, where no one asks his opinion on economic matters and where his popularity is likely to be inversely proportional to the purity of his English. But let eight or ten years pass with normal progress, and he will discover his error. By that time he will, in all probability, find himself under the necessity of making frequent decisions on matters involving the expenditure of other people's money. He must then be prepared to analyze a situation in terms of its ultimate effect on profits and to defend and justify his conclusions orally and in writing. His reasoning must appeal to the business man as well as the engineer. His letters and reports must be couched in language that will produce the desired reaction in the mind of the recipient.

So the engineer generally ends up by placing on a pedestal the very studies under which he chafed as an undergraduate. Students as a class are open-minded and would doubtless be grateful for a little straightforward advice on this matter from engineers who have been through the mill and attained high standing in the profession.

Practical Ideas from Practical Men

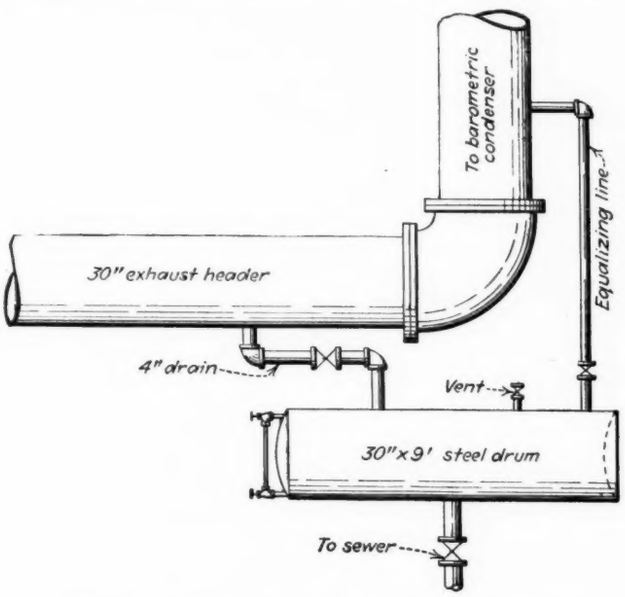


WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for May will be announced this month.

How the Water Hammer in the Exhaust Header Was Eliminated

It might interest some engineers to know of an experience I had with a condensate tank connected to a 30-in. exhaust header on which a fairly high vacuum was maintained.

Throughout the summer months we have been exhausting into this header four 500-ton and one 250-ton ice machines, one 1,500, one 2,000- and one 4,000-cu.ft. air compressors.



Arrangement of condensate tank connections to exhaust header

We experienced no trouble with condensation in the header during the summer months while condensing steam from the engines just mentioned, but during the winter when we did not need so much refrigeration we would possibly be running one ice machine and one air compressor and carrying a high vacuum on the header, and condensation would collect in the header and start a water hammer. When the water hammer occurred, it was necessary to break the vacuum and drain out the header. This operation required time and the water hammer was dangerous. In fact, on one occasion a fitting in the header was cracked.

Finally, a 30-in. by 9-ft. steel drum was installed on the lower end of the header and placed about two feet below the bottom of the pipe. A 4-in. line connected the bottom of the header with the top of the drum and a drain and vent were added to the tank, also a gage glass.

To my surprise, when the bleeder on the bottom and the vent on the top were closed and the 4-in. line into the bottom of the header opened, the condensation in the header would not drain into the drum.

My contention was that when the 4-in. valve between the header and the drum was opened, all the air that the drum contained would rush into the header, thus equalizing the vacuum in the header and drum. I remedied the trouble by tapping the top of the drum and running a 1-in. line from the opening back to the header. After installing the equalizer connection, the drum filled rapidly.

I would like to ask any reader who has had a similar experience, what remedy was adopted and why the condensation would not fall into the drum before the equalizer was put in. W. H. COLLINS.

Fort Worth, Tex.

Not an Unusual Experience

About three years ago a certain engineer took a position as chief of a refrigeration plant of about 140 tons' capacity. The plant was more than twenty years old and in bad condition. The average yearly coal consumption for the five years previous to this man's taking charge was 1,800 tons. The amount of ammonia used was sixty drums a year and the calcium chloride thirty drums. About two months ago this engineer was summarily discharged without any reason being given. During the time he was in charge he had brought the plant from a badly run down condition into fine running order. For the last three years the coal consumption has been 1,500 tons a year, or 300 tons a year less than before he took charge. The ammonia consumption has been reduced to twenty drums a year, representing a decrease of 66 per cent. The consumption of calcium chloride has been cut in half and the water bills reduced 20 per cent.

These reductions were made without even a meter on the feed-water line or other instrument usually found in plants of this size. The ordinary pressure gages, a salometer (belonging to the chief), room thermometer, and one brine thermometer comprised the instruments in the plant.

This experience, together with other similar ones,

brings up the questions, What is the inducement for another engineer to try to do better in this plant? What might this engineer have done if he had had all the modern instruments to work with? This man has only the knowledge that he has gained from observation and long experience. Would he or could he have done better and how much, had he had the benefit of a technical education?

This man does not consider his an exceptional case, as he knows of others quite similar. But after all, is it not experiences like these that cause one to lose faith in his fellowmen? T. M. CHARLESTON.

Boston, Mass.

Boiler-Feed Water Treatment

Will it pay to treat your boiler-feed water? If you are not treating your water, can you answer? If you are treating your water, how much are you saving? Let us consider boiler-feed water under three headings: (1) Water that needs no treatment; (2) water that runs 6 to 12 grains per gal. hardness, and (3) water with 25 grains per gal. hardness.

The first, the ideal boiler-feed water, is one that is seldom found in practice, and needs no consideration. The third, 25 grains hardness, is often found, and the question with this water is not whether treatment will pay, but what treatment will pay best. The second, 6 to 12 grains hardness, is the one most generally found and the one that is the hardest on which to make a decision. The first thing to decide is whether to treat the water or use it raw, and this is the only part of the problem covered here. The water must be analyzed, and as water in open streams or lakes may change with the seasons, samples should be taken in early

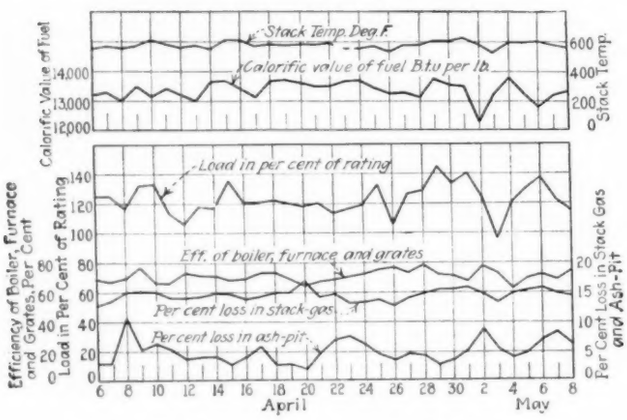

Stack Temp. Deg. F.
Calorific value of fuel B.t.u. per lb.
Calorific Value of Fuel
Stack Temp.
Load in per cent of rating
Eff. of boiler, furnace and grates
Per cent loss in stack-gas
Per cent loss in ash-pit
Efficiency of Boiler, Furnace and Grates, Per Cent
Load in Per Cent of Rating
Per Cent Loss in Stack Gas and Ash-Pit
April
May

Fig. 1—Data on continuous run of No. 6 boiler from April 6 to May 8

spring and midsummer at least. The accompanying table shows analysis on such a water.

These analyses were made on water as used; that is, practically raw water in summer and roughly 25 per cent heating returns and 75 per cent raw water in winter. The samples were taken from the hotwell.

Should this water be treated? There are three savings possible from treating such water: Less cleaning expense; less upkeep on boiler proper, such as tube renewals, and, less loss due to drop in operating boiler and grate efficiency and a possible less blow-down.

To clean a vertical 8,000-sq.ft. boiler, such as is considered here, requires 40 hours' labor and approximately 4 tons of coal, or $50 every 600 to 800 hours of operation at 150 per cent normal rating on one make of boiler and 1,200 to 1,600 hours at same rating on the other type of boiler. The hours in service vary with the seasons of the year. The cost of upkeep on the

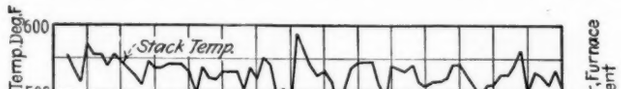

Stack Temp.
Eff of boiler, furnace and grates
Per cent of rating
Per cent CO2 in stack gas
Per cent ash pit loss
Stack Temp. Deg. F
Per Cent of Rating
Per Cent Ash Pit Loss
Efficiency of Boiler, Furnace and Grates, Per Cent
Per Cent CO2 in Stack Gas
June
July
Aug.

Fig. 2—Data on operation of No. 7 boiler from June 3 to Aug. 15

boilers is small. Some tubes are replaced, but the total per boiler per year does not run over $50.

So far, for the worst case, the yearly cost per boiler is around $550, and this amount will not warrant much in the way of feed-water treatment, so the decision must rest on the possible saving in efficiency or at the coal pile. Some operators say they are saving 10 per cent, others less, and some even more. In order to decide for this plant; two boilers, one of each make, were thoroughly cleaned and put in service and run for regular periods and the curves shown in Figs. 1 and 2 obtained. These boilers are equipped with underfeed stokers of the same make and are identical except that

ANALYSIS OF BOILER WATER GIVING IMPURITIES IN GRAINS PER U. S. GALLON

Sample No. 1, Dec. 1924		Sample No. 2—Sept., 1923		Sample No. 3—July, 1919		Sample No. 4 Oct. 1919
Silica	0.350		0.23		0.29	0.58
Oxides of iron and aluminum	0.210		0.03		0.58	0.42
Carbonate of lime	3.456	Iron	0.006	Calcium carbonate	5.59	7.75
Sulphate of lime	None	Calcium	2.6	Magnesium carbonate	3.25	6.97
Carbonate of magnesia	1.078	Magnesium	0.78	Organic	1.74	34.99
Sodium and potassium sulphate	2.003	Sodium	2.1	Sodium chloride	1.45	1.10
Sodium and potassium chlorides	1.360	Chlorine	0.72		Alkaline	Free acid
Sodium and potassium carbonates	1.490	Sulphate radical	1.1			
Sodium and potassium nitrates	Trace	Bicarbonate radical	10.7			
		Suspended matter	1.0			

Samples Nos. 3 and 4 made by same laboratory and samples No. 1 and No. 2 each by a different laboratory.

No. 6 has 12½ per cent more grate area than No. 7. Each has steam flow, air flow, stack temperature, recording three-pen draft meters and individual coal scales, CO_2 readings were taken with an Orsat. The boilers were blown down every six hours and the flues blown every twelve hours. For treatment considered for this plant, there would be little saving due to blow-down, so it was decided that water treatment was not warranted. H. H. FORCE.

Muskegon Heights, Mich.

Why Cannot the Power Factor Be Adjusted?

Our problem amounts to the correct division of wattless current between two plants operating in parallel. One is a steam turbine plant A and the other is a hydro plant B. Plant A has a very good power factor of about 90 per cent and is carrying about two-thirds of the load. Plant B supplies about one-third of the load and has a power factor of about 60 per cent. The power factor of the system is about 88 per cent. The wattless current cannot be divided proportionately between the two plants by changes in the exciting current, as it should.

The following conditions govern: The percentage taps on the high-tension transformers are set to give a 7½ per cent voltage boost, so the busbar voltage is around 2,500 volts whether the plant is running or not. The line loss makes it necessary to give this boost, to maintain proper voltage in the distribution systems. Taps on the transformers at the hydro plant B are set to give neither boost nor voltage drop. Would this difference in the busbar voltages make any difference in the correct division of the wattless current?

Wilkes-Barre, Pa. T. E. LORAIN.

Phasing Device for High-Tension Circuits

In Figs. 1 and 2 are shown complete and disassembled views of a simple device I developed some time ago for phasing out feeders, transformers, etc., on a 6,600-volt

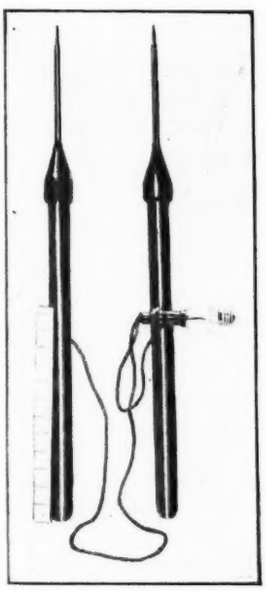


Fig. 1—View of tester assembly

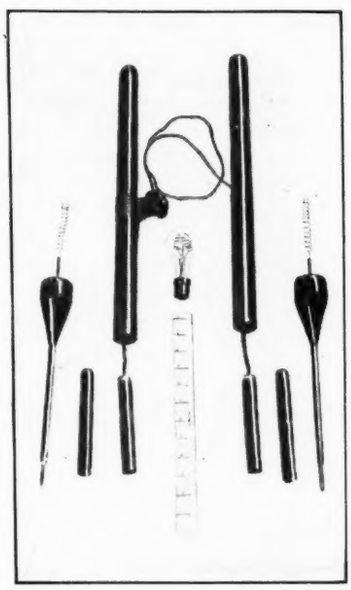


Fig. 2—Apparatus dismantled for inspection

25-cycle system. Fig. 3 is a diagrammatic sketch of connections.

Briefly, the apparatus consists of two metal points, each connected to the inner coatings of two Leyden jars. The outer coatings of the jars are connected by means of flexible leads to the terminals of a neon lamp. The Leyden jars are mounted in handles made of dry, well-seasoned beechwood, well varnished. The top parts, which carry the metal points, are made of bakelite. The Leyden jars are made of glass tube, ⅝ in. diameter and 5½ in. long, with a ⅛-in. wall closed at one end. The outer coatings are made of brass tubing and the inner of tinfoil; both coatings are 1½ in. below the top of the jar. The neon lamp is mounted on one of the handles.

In operation the metal points are brought into contact with the conductors under test, and if pressure exists between them, the lamp glows and this with a

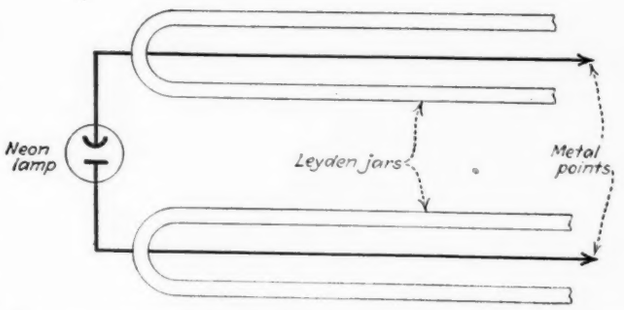


Fig. 3—The metal points are connected to the inner coatings of the Leyden jars and the outer coating to the neon lamp

minimum of risk to the operator, especially on extra high-tension circuits.

The device works well on 6,600-volt 25-cycle circuits for which it was designed. Under test conditions it gave indications from 500 to 20,000 volts, but above this there was a tendency to flash over at the Leyden jars; this could of course be overcome by using taller jars.

At 11,000 volts and over, a 4½-in. Geissler tube in place of the neon lamp gave good results. It takes less current and so lessens the liability to flash over at the jars. MURRAY W. MARTIN.

Glasgow, Scotland.

How the Oil Got Into the Boiler

A few months ago we noticed that considerable oil was getting into our return-tubular boiler and that it was scaling to a noticeable extent. As there were two oil separators as well as two grease traps on the exhaust line, I came to the conclusion that some change in the specific gravity of the oil was causing it. I thought possibly that a 600-deg. oil was too heavy, so changed to a 520-deg., then to a 450-deg. grade without helping matters any. I increased the amount of soda ash feed to the boilers and reduced the amount of oil used in the engines and pumps. At the same time I noticed the vacuum pump was not working as satisfactorily as formerly. It seemed to be getting a little air somewhere in the return line. A thorough cleaning of all the thermostatic disks and dirt legs failed to stop the trouble.

One Saturday afternoon when the machinery was stopped and the shop quiet, I started the vacuum pump and ran it at full speed and made an inspection of all the returns. Close to the oilroom I detected a slight hissing. Upon tearing up the floor I discovered two small holes rusted in the bottom of the 2-in. return line. Water and oil waste from the filter in the oil-room had soaked back to the holes and been drawn into the pipe and passed over to the receiver of the boiler-feed pumps. A new length of 2-in. pipe cured the trouble.

Columbus, Ohio. W. B. MCCLOUD.

Comments from Readers

Using Sulphur Tapers to Locate Ammonia Leaks

I have read with considerable interest the contribution of D. L. Corn in the May 12 issue on the subject of "Using Sulphur Taper To Locate Ammonia Leaks," and am unable to find anything in my personal experience that would support, in the slightest degree, the theory advanced by him.

I have used burning sulphur for detecting ammonia leaks, not only in all types and arrangements of ammonia piping in all sorts of places, but around compressors of all different makes and types and regardless of whether the ammonia leak was large or small or where located; no evidence of explosion has been noted, not even the slightest sign of explosive action has been apparent.

When sulphur fumes and ammonia fumes unite, a white smoke or fog is produced due to the chemical action that occurs, but this action is in no way explosive so far as I have ever observed.

From a study of Mr. Corn's letter it would appear that he has misinterpreted the cause of the explosions which he says took place when a sulphur taper was moved around the cylinder-head joint, and as a consequence has drawn erroneous conclusions therefrom. It seems to me that some other cause in no way connected with the use of sulphur was responsible for the accident described. C. T. BAKER.

Atlanta, Ga.

Utilizing Waste Firebrick

Having read the recent comments from readers on the subject of "Utilizing Waste Firebrick," it seems to me that James Johnston in his letter in the April 21 issue has summed up the situation accurately. F. W. Reisman's letter in the May 26 issue may answer the argument on the use of grinding machinery for this work, but I do not believe that Mr. Reisman takes into consideration the fundamental principles necessary in making a patching material from waste firebrick and refractory cement.

One of the most important physical characteristics of a grog base is its granularmetric analysis. The use of crushing machinery in a plant without proper screening to separate the various size particles is certainly not likely to give uniform results. If screens are installed so as to obtain segregation of the various sizes, it is quite necessary to know the correct proportion of each size to incorporate in the patching mixture.

In the first place, it has taken many months of research to develop the granularmetric analysis of the base of high-grade refractory cements. Proportioning of the sizes is essential to obtain the proper plasticity with a minimum of shrinkage. These points are as essential as high refractory value is.

I do not wish to dispute the value to be obtained from old brickbats, but I do believe that it is rather an expensive proposition to obtain this value without sacrificing too many other important details. I should like to ask Mr. Reisman if he has ever had any trouble with getting ground clinker and ash in the ground brickbats, which defeated the purpose of having high refractory value, by acting as a flux and actually lowering it.

In the last paragraph of his letter Mr. Reisman says that one "would do well to get some expert advice on this subject," and I quite agree with him. A plant trying to make its own patching material or refractory cement is trying to compete in a slipshod way with manufacturers who have spent large sums of money in research and who are equipped to manufacture these materials on a large scale, which is just about as foolish as a power plant trying to compete with a firebrick manufacturer by trying to make its own firebrick.

New York City. H. E. MARTIN.

Auxiliary Drive and the Heat Balance

After twenty years' designing, building and fussing with the small steam turbine, I am still its friend. So the discussion of this topic on page 508 of the March 31 issue makes me want to reply.

Briefly, the author contends that heat balance is almost invariably improved by electric drive, assuming that bled steam is available for feed-water heating. He compares motor and turbine drive for an isolated non-condensing plant distributing both power and heat. The question is which auxiliary drive will secure the lowest plant cost of 100 units of electricity for outside use.

He assumes that the main units convert 10 per cent of the energy supplied into electricity. Steam conditions not being stated, I assume feed water at 200 deg. F. evaporated into steam at 150 lb. gage with 100 deg. superheat and a 2-lb. back pressure in exhaust. Then with the assumed boiler efficiency at 70 per cent, coal at 12,400 B.t.u. per pound, the actual evaporation is 8 lb., the heat put into each pound of steam is 1,084 B.t.u., and from the entropy-heat diagram the available heat is 178 B.t.u. Comparing the assumed 10 per cent of energy supplied with this available heat, the "potential efficiency" of the main unit, or per cent of available heat turned into work by it, becomes 61 per cent, which is fair for the smaller power plants. This fixes the water rate at 34 lb. per kilowatt-hour.

But the assumed 2½ per cent conversion for the auxiliary turbines results in a water rate of 94 lb. per b.hp.-hr., which is entirely too high for the modern small turbine. With the main turbine at 61 per cent, I assume the potential efficiency of the small turbine at 30 per cent, which gives a water rate of 48 lb. This is still high enough for the steam conditions.

Thinking of the 100 units of electricity assumed for outside use as kilowatt-hours, the author's assumption of 7 additional units diverted to the motors with 5 units delivered to the motor shaft means an over-all

efficiency of 70 per cent for motors, wiring and control. That is probably high enough. For the turbine auxiliary drive, the equivalent of 5 kw.-hr. at the shaft, or 6.7 b.hp., follows.

With the approach of the main issue now clear, I must confess to a growing suspicion that the intense study of ways and means of securing the elusive heat balance has submerged power-plant designers too deeply in the complex details to retain the true objective. A power plant producing current or steam to sell is expected by its stockholders to produce dividends like the factory making the motor or the turbine. There is such a thing to consider as the "dollar balance," although it is not so attractive technically to the designing engineer as the heat balance.

A study of values then will help to answer the question whether it is better to use current for motors or steam for turbines. With coal at $4 a ton the evaporation at 8 lb., adding 40 per cent to fuel cost for labor charges and 20 per cent for capital, the cost of 1,000 lb. of steam is fixed at 40c. Assuming current to sell at 4c. per kw.-hr., a sort of mean between power and lighting rates, the selling value of the 7 kw.-hr. diverted to the motors is 28c. To produce it with the 34 lb. water rate of the main turbine will require 238 lb. of steam, worth at 40c. per 1,000 lb. only 9½c. We must realize that current is essentially a higher-cost product than steam, involving more of equipment, labor and capital.

But what about the auxiliary steam turbine? With the 48 lb. water rate and the 6.7 shaft horsepower, the steam per hour is 322 lb., worth 12.9c. at 40c. per 1,000 lb. But the turbine in this comparison is fairly charged only with the excess of steam over that required by the main unit to produce the 7 kw.-hr. diverted to the motors. This is only 84 lb., worth 3.4c. The answer then is to the question whether it pays to use 28c. worth of current in the motor for the sake of saving the 3.4c. plant cost of steam.

Thus far the possible use of exhaust steam has not been considered. The 100 kw.-hr. of current to be sold requires 3,400 lb. of steam for the main unit. Add to this the 322 lb. per hour for the auxiliary turbine and about 5 per cent for other uses and leakage, making a total of 3,900 lb. of feed water per hour. Deducting from the initial total heat of steam the 30 per cent of available heat converted by the small turbine, the heat of liquid below back pressure, a small amount for radiation and there remains 1,000 B.t.u. per pound of exhaust for feed-water heating. The temperature rise in feed water due to small turbine exhaust then is 83 deg. If the feed water is to be heated from 70 to 200 deg., the range is 130 deg. and the small turbine exhaust leaves it short 47 deg. This may properly be made up in this non-condensing plant by exhaust from the main turbine. For 950 B.t.u. available in the main exhaust the weight so utilized is 193 pounds.

Another phase of the question depends on the use of steam for feed-water heating bled from one or more of the high-pressure stages of the main turbine. As the feed temperature approaches the boiling point under pressure, the boiler steams more freely, the capacity increases and the efficiency improves. Then the bled steam has had part of the available heat converted into work, the latent heat is returned to the boiler and the condensate mingles with the feed. This looks good, but it would not pay to use bled steam where exhaust can furnish the heat, since the exhaust results from converting a larger proportion of available heat into work. Moreover, this latent heat, which is all available for heating feed water, increases with lower pressures. Thus, at 100 lb. gage the latent heat is 880 B.t.u., while at 2 lb. it is 970.

But the conditions are different when the heating of feed water by chimney gases is taken up. Apparently, the lower the temperature of chimney gases the higher the plant efficiency, especially as draft seems to be produced more economically by mechanical means than through change in specific gravity by heat. The answer lies in the makeup of the gases. The ultimate analysis of both hard and soft coal shows the presence of sulphur and hydrogen. In soft coal the proportion of hydrogen is often as much as 5 per cent, or 100 lb. per ton. In burning in the boiler furnace, this hydrogen produces 900 lb. of water, or 108 gal.—more than two barrelfuls.

Suppose an economizer is to be used and the feed water is passed through it at a temperature below the dew point of the chimney gases loaded with this 900 lb. of water vapor. The economizer tubes "sweat," and the floating ash from the coal combines with the moisture to form a muck on the tubes, which entails continual use of the scraper to maintain efficiency. The sulphur of the coal oxidizes in the boiler furnace and combines with the moisture on the tubes to form acids that may be corrosive to piping. But, if the feed water is first heated to a temperature above the dew point of the gases, as it may be by exhaust steam, then this sweating of tubes does not occur and both hydrogen and sulphur products pass off harmlessly through the chimney. What happens elsewhere is another question.

Nearly the same argument applies to the use of chimney gases for preheating the air used for combustion, except that the corrosive action may be still more troublesome on account of the thin metal sections naturally used with the low pressures and the lower rate of heat transfer. And the deposit of moisture will be most active in cold weather just when preheating is most desirable. Again, the trouble may be avoided by using exhaust steam to heat the cold air above the dew point of the gases.

In so using exhaust steam, both available heat and latent heat are utilized and this part of plant operation approaches 100 per cent of heat efficiency, since only the small percentage of steam heat lost in radiation really escapes.

To make such a discussion more nearly complete, consider briefly the condensing type of power plant. Here the same arguments apply in general, although the heat energy back of current diverted to auxiliary motors is more likely to escape unnoticed in the condensing water. If the auxiliaries are driven by steam turbines, any excess of exhaust steam over the requirements of feed-water or other heating may be fed back into the lower stages of the main turbine. This requires the same co-operation of the turbine designer as results in providing for bled steam from the upper stages. And it would be worth while. The available heat from 150 lb. plus 100 deg. superheat to 2 lb. back pressure is 178 B.t.u.; and from this back pressure to 28.5 in. vacuum the available heat is also 178 B.t.u. And the potential efficiency of the main turbine probably increases toward the vacuum end through a smaller

proportion of leakage losses and a lesser skin friction. In a relatively small way such an arrangement has been tried on a turbine-driven municipal pumping plant —and it worked.

A remaining question is that of control. No form of drive for auxiliaries responds quite so sweetly to speed control as the small steam turbine. The basis for it is a simple balanced steam valve. And it seems certain that an electrical designer who can devise the apparatus for central control of a variable-speed motor on an induced-draft fan could find a way to operate the valve on the auxiliary turbine. Where central control is not desired, a throttle valve for the attendant is sufficient. In case the turbine drives a blower or a centrifugal pump that is always primed, the usual speed governor and emergency stop are not really necessary, as the driving power required runs up with the cube of the speed. Then there is such a thing as designing a turbine to be quickly self-limiting in speed. This reduces the turbine drive to the simplicity of the motor with main bearings only, while it has a wide speed range, freedom from burn-out and a higher plant efficiency as advantages. Then it has the ability to start under load, for under full steam pressure the starting torque as determined by brake test, is 50 to 75 per cent greater than at full speed. C. V. KERR.

Los Angeles, Calif.

Diagrams from Low-Pressure Cylinder with Condensing and Non-Condensing Operation

I read with interest the comments of Mr. Pascoe and Mr. Carr in the April 21 issue on my indicator diagrams, as published in the Feb. 17 issue. It would

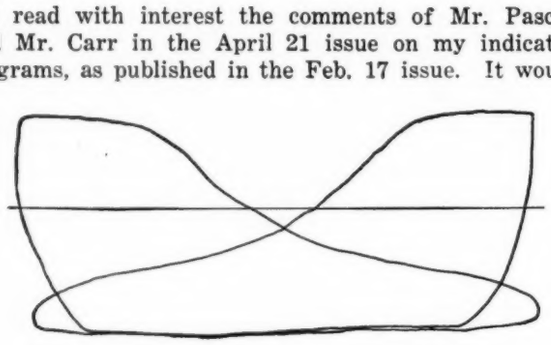


Fig. 1—Diagram from low-pressure cylinder while running condensing

appear that they both have a wrong view on the subject, especially Mr. Carr, when he says that such a diagram shows certain features that could not exist with any valve setting. To confirm my statement that such a diagram as I have shown is possible, I would refer Mr. Carr to a blueprint that was given as a supplement to *Power* some years ago, entitled "What the Diagrams Tell." On this blueprint there is a diagram similar to the one I have shown, and on which the caption reads, "Excessive compression with low steam pressure." Apparently, Mr. Carr has made the mistake of considering the expansion line as the compression line and vice versa.

Three diagrams that were taken within a period of five minutes are reproduced herewith. Fig. 1 was taken with the engine running condensing; Fig. 2 was taken running non-condensing with cutoff taking place at the same point of the stroke as in Fig. 1. For the sake of clearness only the crank-end diagram is shown in Fig. 2. It shows that the compression pressure runs above the admission pressure, which is about 8 lb. as stated in my previous article. This can be readily checked by comparing the two diagrams and noting the distance from the top of each diagram to the atmospheric line.

On the diagram, Fig. 2, the expansion and compression lines are indicated. Following the diagram the admission is at *A*. As the compression was high, as

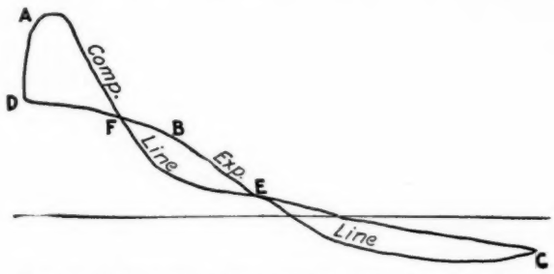


Fig. 2—Diagram from same cylinder as Fig. 1 with engine running non-condensing

soon as the admission valve opened the pressure dropped to *D*. The cutoff takes place at *B* and the expansion runs down to *C* when release takes place and the pressure begins to rise to the exhaust-line pressure. Finally, compression takes place and the pressure runs up above the admission pressure, crossing the expansion line at *E* and *F*. Diagram Fig. 3 was taken with the engine running non-condensing the same as in Fig. 2, but the point of cutoff is much shorter.

It seems to me that overhauling the indicator, as Mr. Carr suggests in his comment, would not change the diagram much, as I believe it shows the true working conditions of the engine.

With regard to Mr. Pascoe's suggestion as to the proper lubrication of the indicator, I will say I am using a medium-bodied machine oil, but to see what the

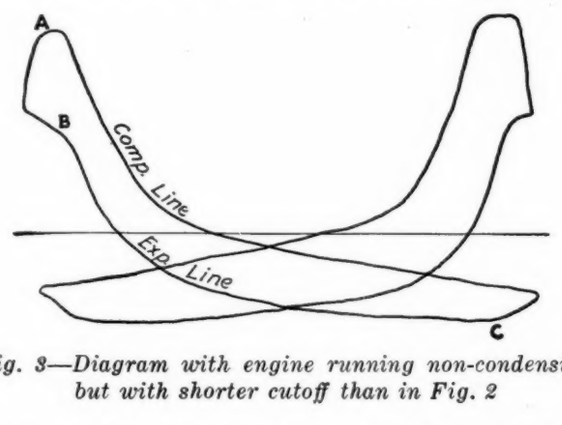


Fig. 3—Diagram with engine running non-condensing but with shorter cutoff than in Fig. 2

result would be I tried a heavy cylinder oil and there was no material difference in the diagram only that the expansion line was slightly wavy.

Webster, Mass. WILLIAM HAMPSHIRE.

A 60,000-kw. turbine taking 10 lb. of steam per kilowatt-hour delivers 10,000 lb. of steam per minute to the condenser. At 29 in. vacuum each pound has a volume of 657 cu.ft., giving a total volume delivered of 6,570,000 cu.ft. per min., or the entire volume of a 20-story building 100 ft. square, in 22 seconds.

Questions and Answers

Conducted by

Franklin Van Winkle

Advantage of Outside Packed Piston Pump

What are the advantages of an outside packed plunger pump over a piston pump? *R. L. C.*

The outside packed plunger pump is easier to repair damage done by gritty water, is better adapted to pumping against high pressures, as the condition of the packing is known at sight, and is easier to repack than an ordinary piston pump. The plunger pump has the disadvantage of requiring more floor space and requiring more power for its operation than a piston pump of the same capacity.

Single-Strap Butt Joints

What advantage has a riveted joint with single butt strap over a simple riveted lap joint? *W. E.*

A joint having a single strap or cover plate is only equivalent to two lap joints near together and has no advantage in strength or durability over a lap joint, as the plates are subjected to the same bending action that is likely to produce cracking and leakage where the bending is most severe. As in a lap joint the rivets are subjected to tensile as well as shearing stresses and there is the disadvantage of requiring construction and calking of two lap joints in place of one.

Bent Rocker on Single-Valve Engine

Why do some single-valve automatic engines use a bent rocker for the valve motion? *M. J. T.*

With straight connections the valve may have equal laps and give equal port openings, but on account of the irregularity due to the connecting rod, commonly designated "angularity of connecting rod," the piston positions at cutoff will be unequal and equalization of the cutoffs can only be made at the expense of the lead. By the use of a bent rocker an irregularity may be introduced in the valve motion which may be made to equalize the cutoffs and so neutralize the angularity of the connecting rod as not to interfere with the equality of the leads.

Connections for Drinking-Water System

In a drinking-water system of piping for a building with a cooler and circulating pump in the basement, should connections for fountains and faucets be taken out of the rising or the return lines? R. L. C.

The fixtures should be supplied from outlets in the rising lines. If taken from the return lines, the water supplied to every fixture would be warmed by absorption of heat from traversing the full length of the rising line and also the return line from the top down to the outlet. By taking the connections out of the rising line, the supply in each case would be warmed from traversing only the necessary distance to supply the fixture.

Larger Safety Valve for Lower Pressure

Will a boiler require a larger safety valve for low-pressure or for high-pressure service? *G. E. L.*

A larger safety valve will be required for low-pressure service, mainly because the lower the pressure the greater the specific volume or number of cubic feet per pound (weight) of the steam generated, and for the same temperature of feed water and the same boiler evaporative capacity there would be more pounds of steam evaporated per minute at lower pressure. The safety valve must be capable of relieving the boiler of steam as fast as it can be generated, and in addition to the requirement to discharge a larger volume of steam per minute, the safety valve for low-pressure service must be larger to provide for lower velocity of discharge.

Single-Riveted Girth Joints

Why are single-riveted lap joints used for girth seams of externally fired boilers while double-riveted lap seams frequently are used for girth seams of locomotives? *W. L. T.*

Single-riveted girth seams are sufficient for cylindrical shells where the tension is low and where exposure to the fire makes it necessary to employ joints with as little overlap of the plates as consistent with the necessary strength. The rigidity of the joint is increased by the circular form of the shell, and there is little tendency of distortion and bending action that exists when a lap seam is used as a longitudinal seam. Double-riveted lap joints are used for girth seams of locomotive and internally fired boilers and for long steam drums to resist severe transverse stresses.

Thermal Efficiency of Turbo-Generator Set

What is the thermal efficiency of a turbine-generator set? *J. M.*

The thermal efficiency of a turbine-generator unit is the ratio represented by a unit of energy delivered at the generator terminals, such as one kilowatt-hour (3,415 B.t.u.) divided by the energy absorbed in evaporating the steam supplied to the turbine for producing this amount of power if raised from water at exhaust-steam temperature. Assume that one kilowatt-hour may be produced on 16.5 lb. of steam at 180 lb. abs., 100 deg. F. superheat, expanded to 29 in. vacuum. The total heat of steam, 180 lb. abs., 100 deg. superheat from the steam table is 1,254 B.t.u. per lb. above 32 deg. If evaporated from 79-deg. water, corresponding to a 29-in. vacuum, this will be $1,254 - (79 - 32) = 1,207$ B.t.u. per lb. Then the total heat supplied per kilowatt generated is $16.5 \times 1,207 = 19,915$ B.t.u. per hour, and the thermal efficiency, or ratio of heat energy per kilowatt-hour to the heat supplied the steam, is $3,415 \div 19,915 = 0.17$, or 17 per cent.

Inclined Grate for Hand Firing

What benefit is obtained in having the rear end of a hand-fired grate lower than the front end? J.D.B.

When the furnace air supply is admitted through front doors of the ashpit, the checking of the draft by the bridge wall results in a stronger draft in the rear end of the furnace and more fuel is burned at the rear end than at the front end of the grate. By having the grate inclined toward the rear end, the air supply is intercepted and more uniformly distributed. In addition to this there is an advantage in having the grates slope about 1 to 20 toward the bridge wall so it will be easier to stoke the rear end of the furnace.

Detecting Ammonia in Brine

The writer is of the opinion that one of the brine tanks has a slight ammonia leak. Is there a way to tell or to determine the exact amount of ammonia that this brine could contain per cubic feet? A 2-oz. sample taken from this tank will turn pink when adding 3 drops of phenolphthalein test solution. E. S.

Phenolphthalein cannot be depended upon as indicating the presence of ammonia although it turns pink. The action is due to the alkalinity of ammonia, and it is possible that the brine itself may be slightly alkaline.

For this reason, in testing, the phenolphthalein drops should be replaced by a phenolphthalein paper, or litmus paper. Instead of immersing the paper in the suspected brine, a drinking glass should be half filled with the brine and a small amount of caustic soda added. After allowing sufficient time for the caustic soda to dissolve, the glass should be covered by a strip of glass to the underside of which is attached a piece of litmus paper moistened at the ends to cause it to adhere.

If the brine contains ammonia the paper will be turned pink by the action of the ammonia fumes. Warming the brine will hasten the action. If the paper is not affected after four or five minutes, the brine contains no ammonia. The amount of ammonia present can be approximated by determining the time elapsing before the paper changes color. As a guide a known amount of ammonia may be added to a given weight of pure brine and the time required noted.

Operation of Steam Loop

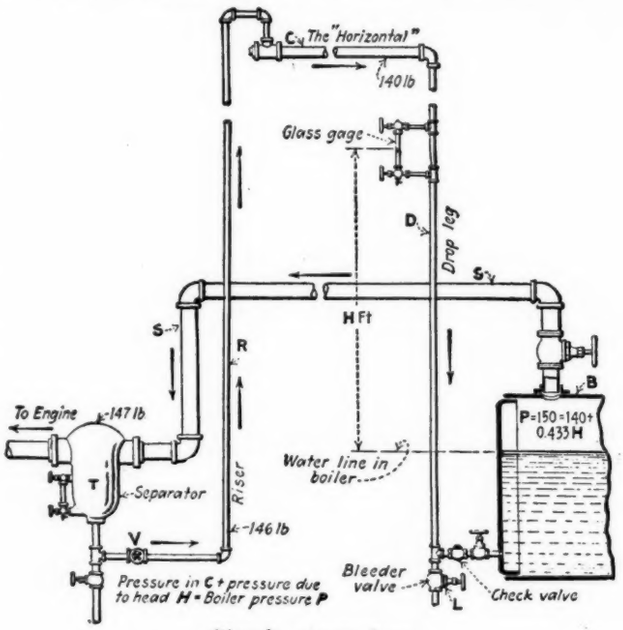
How does a steam loop operate for returning condensate to a boiler? R. L. G.

The figure illustrates the general arrangement and operation of a simple steam loop for returning drips to the boiler B from a separator T in the steam line S that is supplied out of the same boiler. The principal parts are the "horizontal" C which acts as a condenser and receiver; the riser R which connects the drain pipe of the separator with the top of the horizontal; and the drop leg D which connects the lower end of the horizontal with the feed connection of the boiler.

Circulation is first established by opening the bleeder valve L at the foot of the drop leg D.

Then with the valve V at the foot of the riser R partly open, water in the separator and riser R is discharged to C and drained off at L. When steam appears, the valve L is closed. The water then discharged from the separator is delivered to the riser R in form of a spray that is gathered in the horizontal C from which it is drained into the drop leg D and in which a head H becomes built up. When the pressure due to the head H plus the pressure in the horizontal becomes greater than the boiler pressure, water in the drop leg will be delivered to the boiler when there is additional building up of the head in D sufficient for overcoming pipe friction and opening the check valve.

The density of the spray must be little enough for the pressure in the riser to raise the spray and deliver it against the pressure in the "horizontal," and the lower this pressure the higher must be the head H for effecting discharge to the boiler. Since each foot head of water exerts a pressure of about 0.433 lb. per sq.in., then when P is boiler pressure, lb. per sq.in., H the head in the drop leg in feet, and C the pressure in the horizontal, to balance the pressure in the boiler requires $P = C + 0.433\ H$. Where, as indicated, $P = 150$ and



Simple steam loop

$C = 140$ lb. per sq.in., $150 = 140 + 0.433\ H$ and H = about 23 feet.

When the pressure C depends on condensing, as in the simple steam loop, it will be variable and in place of a "horizontal" acting as a condenser, the Holly loop employs a vertical receiver in which the pressure is maintained constant by bleeding the receiver with a reducing valve, the discharge from which may be turned into a feed-water heater or utilized otherwise.

Provision for Drainage of Superheated Steam Lines

Where an engine is supplied with superheated steam, is it necessary to provide a separator or traps for draining the steam supply line? G. T.

If the temperature of the steam were never less than the saturation temperature, there would be no need for special provision to remove moisture. But there is a possibility of the superheater becoming flooded, and slugs of water may be carried over into the pipe lines, and when starting up, there always is some condensation to be taken care of. Hence lines for superheated steam should be pitched and provided with traps and means for drainage the same as lines intended for saturated steam in addition to suitable drains at the superheater; and in most cases it is advisable to provide a separator at the engine throttle, since it is useful also in filling the office of a receiver.

A new slant on things observed in and out of the power plant

What Happens and Why?

How an Injector Works—Part II

THE principal action taking place in the operation of a condenser is a collision between a jet of steam moving at enormous velocity and a stationary (comparatively) mass of water. It is the "blow" of this collision which forces the water, along with the condensed steam, into the boiler.

No Momentum Lost in Collision

The article in the previous issue showed that when two bodies collide, the total momentum of the system is the same after the collision as before. The kinetic energy is also the same in the case of perfectly elastic bodies such as are approximated by billiard balls, but in the case of inelastic bodies, such as putty for example, the collision always involves a loss of energy, in spite of the fact that there is no loss of momentum.

The previous article also showed that where a moving inelastic body strikes a stationary body of the same weight, half of the energy is necessarily lost.

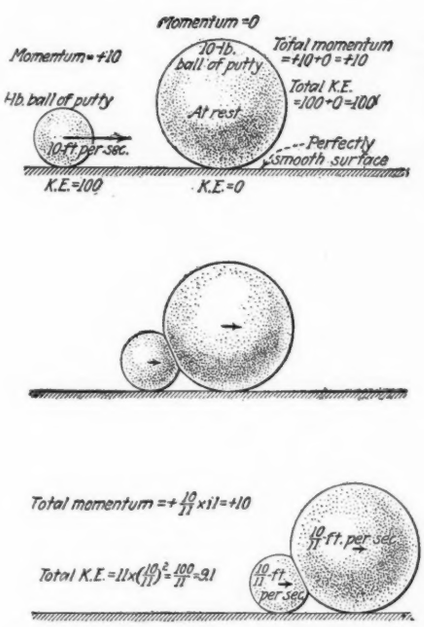


Fig. 1—With the stationary mass ten times the other, collision wastes 90.9 per cent of the energy

Where the moving body is lighter than the stationary one, much more than half of the kinetic energy is lost. A study of Fig. 1, for example, will show that where the stationary body weighs ten times as much as the moving body, the kinetic energy after collision is only 9.1 per cent of that before. At the same time, strange as it may seem at first, there is no reduction in momentum.

A similar case is shown in Fig. 2. Here a rifle bullet assumed to weigh 1 oz. is shot up vertically at a velocity of 2,600 ft. per sec. into a conical hole in a 12-oz. block of iron. This illustration is of particular interest, because the velocity of the steam jet in an ordinary injector is frequently in the neighborhood of 2,600 ft. per sec. and the weight of water handled approximately twelve times that of the steam. The moving steam must seize and drag along with it the water much as the bullet seizes and drags along the block of iron. In both cases there is a tremendous loss of energy in the process.

The Bullet Analogy

Since again we care for comparative figures only, a new unit of momentum and kinetic energy may be adopted,

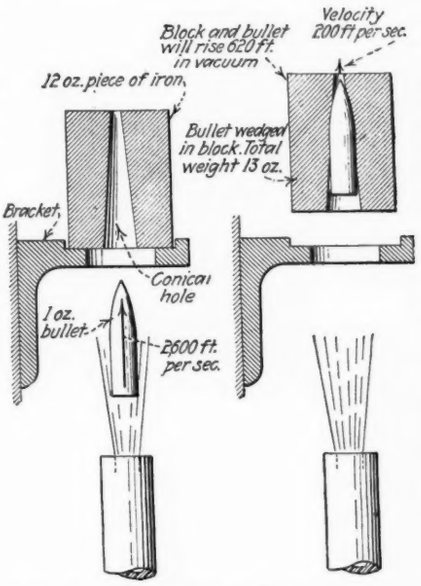

Block and bullet will rise 620 ft. in vacuum
Velocity 200 ft per sec.
12 oz. piece of iron
Bullet wedged in block. Total weight 13 oz.
Bracket
Conical hole
1 oz. bullet
2600 ft. per sec.

Fig. 2—Rifle bullet will give block a velocity of 200 ft. per second

namely, that of one ounce moving upward at the rate of one foot per second. The momentum of the bullet is then +2,600. The final momentum of the iron with the bullet wedged in it must also be equal to +2,600 on the principle that collision causes no change in total momentum. Since the total weight is 13, it follows that the upward velocity must be 200 ft. per sec., a velocity sufficient to carry the combined mass to a height of 620 ft. in a vacuum. The original kinetic energy of the bullet was $2{,}600^2$ and that of the block with the bullet in it is $200^2 \times 13$. The latter is only one-thirteenth of the former, corresponding to a mechanical efficiency of the bullet as a lifting device of 1/13, or 7.7 per cent. It is also evident that the resistance of the air would prevent the block from rising to the full theoretical height of 620 ft.

As already hinted, this action is closely parallel to that of the injector shown diagrammatically in Fig. 3. Steam expanding through the nozzle acquires a velocity of 2,600 ft. per sec. It then collides with a mass of practically stationary water in the proportion of about twelve parts (by weight)

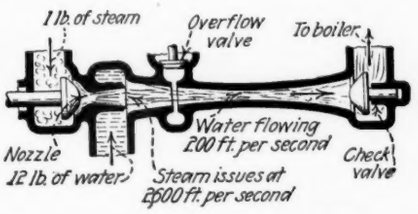


Fig. 3—Steam gives water velocity of 200 ft. per second

of water to one part of steam. This collision, under ideal conditions, would give the combined mass a velocity of 200 ft. per sec. which, again under ideal conditions, would be sufficient to raise it vertically 620 ft. or deliver it against a pressure of 620 ÷ 2.3 = 270 lb. The converging portion of the "Venturi" section allows for a gradual reduction of volume while the steam is condensing. The diverging portion allows the velocity to be turned back into pressure with a minimum of loss.

Injector Not an Efficient Pump

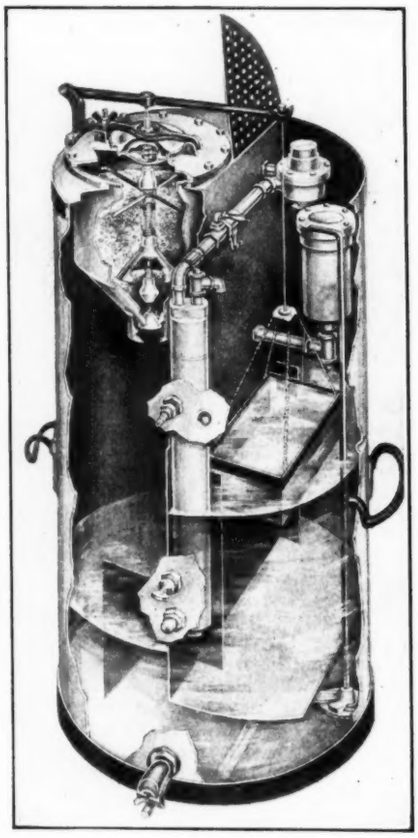
Actually, an injector working under these conditions would never deliver water against this pressure. But even in this ideal case the efficiency would be only 7.7 per cent in terms of the kinetic energy in the steam jet, which in turn is only a fraction of the original heat energy of the steam. So the net efficiency of an injector as a pumping engine is extremely low. As a water-heating device its efficiency is practically 100 per cent, since all the energy not turned into pumping work appears as heat.

Because the heat in the steam supplied to an injector is almost all returned to the boiler, it has been claimed in the past that the operation of an injector involves no energy loss. This is a fallacy. If the injector were not used, it would generally be possible to heat the feed water by exhaust steam from engines or auxiliaries. The heating of the feed water by the injector, which does nothing but a small amount of pumping work, prevents the heating of it by exhaust steam, which must therefore be thrown away. Where injectors can be made to operate with low pressures, it is a different story. Injectors have recently been constructed to operate with the exhaust steam of locomotives, delivering the feed water into the high-pressure boiler.

New and Improved Equipment

Oxweld Portable Acetylene Generator

A small generator for producing acetylene at low pressure for welding and cutting has recently been developed by the Oxweld Acetylene Co., New York City. This supplements a line of larger generators, which are used to supply pipe lines in shops where much cutting and welding is done.



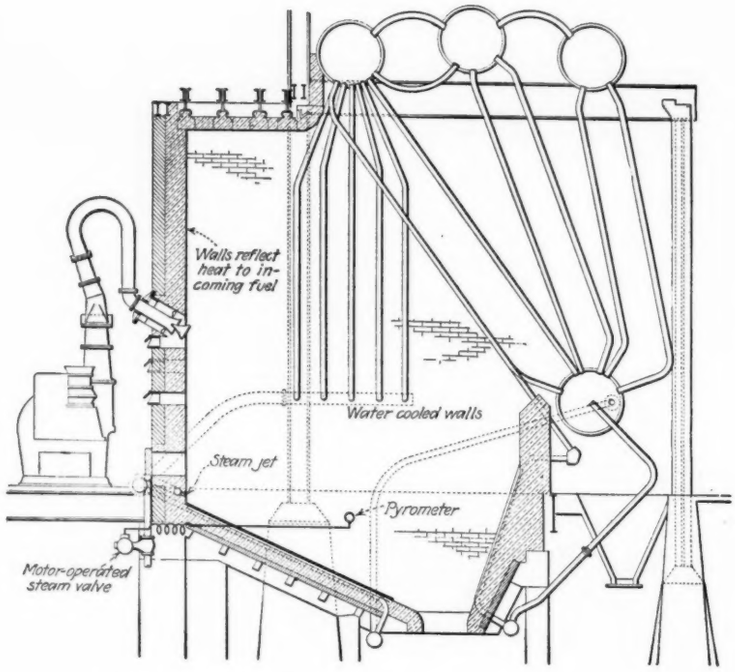
Sectional view of portable acetylene generator

The new generator, which takes 35 lb. of carbide at one charge, can be transported readily from place to place, thus providing a portable supply of generated acetylene gas. Empty, the generator weighs approximately 210 pounds.

Referring to the illustration, a vertical partition extending nearly to the bottom into a water seal, divides the generator shell. The left-hand side is gastight and contains the carbide hopper at the top, while the upper part of the right-hand side contains gas regulating and protective devices, and an automatic carbide feed control. Generation of the first acetylene causes water to rise on the right-hand side of the partition high enough to all but submerge a pan full of water attached to a control lever. This pan normally acts as a weight acting counter to a spring, but as the water rises it carries the float with it and the carbide hopper valve is closed by the action of the spring. As acetylene is drawn off, water rises in the gas compartment and correspondingly lowers under the float, which in turn depresses the spring and allows a small amount of carbide to drop into the generator and restore equilibrium conditions.

Furnace Engineering Co. Constant Temperature Furnace

The Furnace Engineering Co., New York City, in an effort to simplify the boiler-furnace problem has brought out a constant-temperature furnace to be used in connection with its unit system of pulverized fuel. The furnace is designed to maintain a uniform temperature of gases at the boiler tubes, this temperature being below the fusion point of the ash or below the softening temperature of the brickwork, thus preventing the accumulation of hard ash in the boiler tubes and the erosion of the furnace walls.



General arrangement of constant-temperature furnace

The regulation of the temperature is accomplished by the control of direct boiler-heating surface exposed to the flame in proportion to the amount of coal burned per unit of area and time; that portion of the direct heating surface being located in the floor of the furnace on which ash is allowed to accumulate and cover the floor during light loads. The ash is removed by intermittent shots of steam from nozzles during heavy loads, thus exposing additional direct heating surface. A pyrometer placed in the furnace walls controls a motor-operated steam valve and also in emergency cases the air supply or other means by which the temperature is controlled.

A feature of the design is, that it is adaptable to practically all types of water-tube boilers. The boiler-tube surfaces placed in the floor of the furnace are covered with cast-iron blocks which transmit the heat to the circumference of the tubes. The tubes being inclined, increase the water circulation, which becomes more rapid as the steam and water reach the vertical tubes on the side walls. The tubes on the walls tend to reduce the temperature on the surfaces of the brickwork and prevent erosion.

It is claimed by the manufacturer that this arrangement enables the boiler to respond quickly to sudden demands for steam as well as reduce the time for getting up steam. It is also claimed that this type of furnace can be designed for maximum load conditions burning inferior fuels and for maximum

air preheat, and that by means of the pyrometer control it will maintain a constant temperature of gases to conform with the maximum burning efficiency of the fuel.

This new development is the invention of J. G. Coutant, who has assigned it to the Furnace Engineering Co.

Phillips Coal Spout Swinger

To deliver a uniform rate of coal feed, there has been developed recently and placed in operation a device applicable to either the chain grate or the underfeed stoker using swinging coal spouts. This machine swings the spouts continuously and, being driven directly from the stoker drive, its speed varies directly with the speed of the stoker and in this way automatically maintains the fuel supply at a constant level in the stoker hoppers. Its general arrangement is shown in the accompanying illustrations. The device is made by the Henry Pratt Co., of Chicago.

Fig. 1 shows front and back views of a two-spout machine with right-hand underfeed stoker drive gear. In the front view (top view, Fig. 1) the right-hand shuttle cover plate has been removed to show the reverse sprocket *A* and the method of engaging the drive chain. The left-hand shuttle, which has the cover *B* in place, shows the hinged yoke *C* in the position it occupies when disengaged from the spout. This yoke hinges forward into a position at right angles to and embracing the spout when the machine is in service.

There are two adjustable reverse brackets, one on each end of the shuttle travel, which are set to regulate the range of travel of each shuttle. On machines having two or more spouts to swing, the shuttles are set so that the load is equalized. This is shown in the lower view Fig. 1, where the right-hand shuttle is in the center of its travel, while the left-hand shuttle is at the end of its travel and is being reversed. Thus the energy stored up in bringing the spout full of coal up to the high point in its arc of travel, which is the point of reverse, will be given up in bringing the other spout up to a like position. With such an arrangement the load is balanced and the power required a minimum.

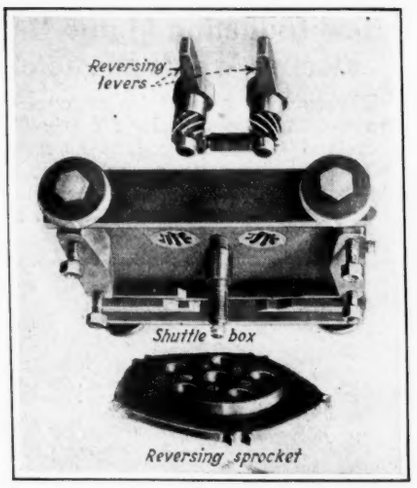


Fig. 3—Component parts of reversing mechanism

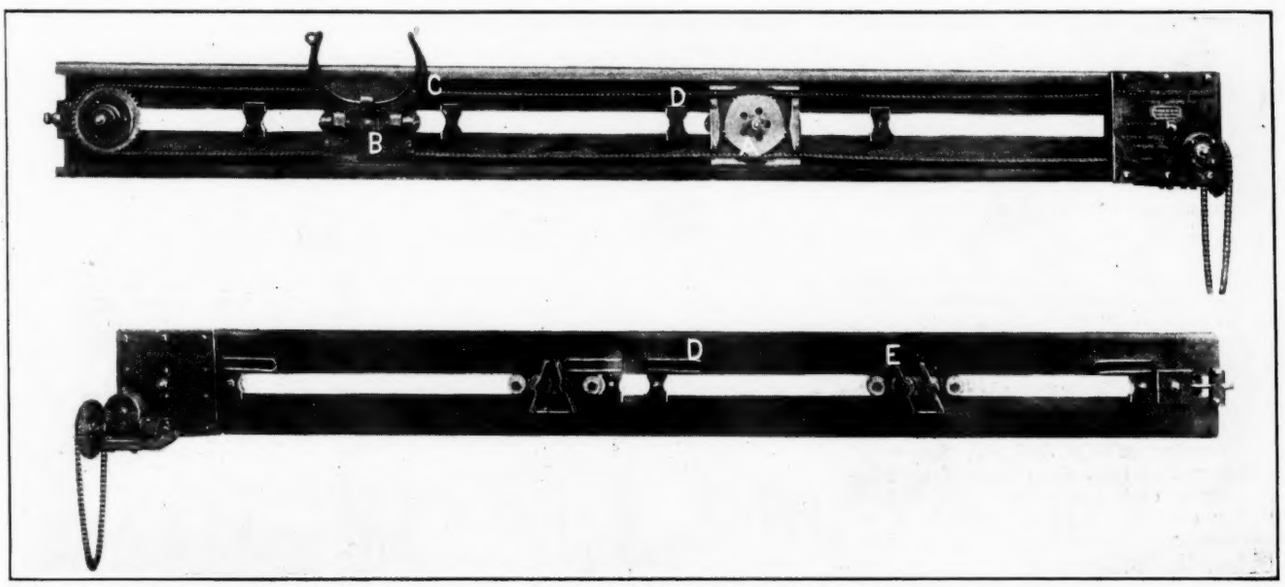


Fig. 1—Front and rear views of two-spout machine with right-hand underfeed stoker drive gear

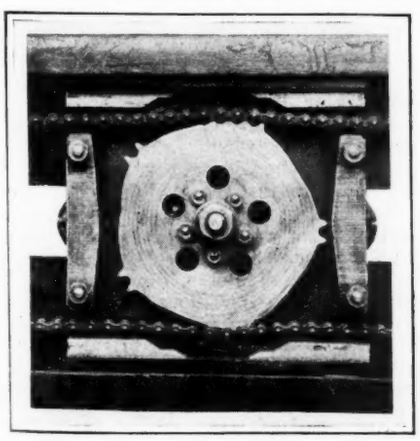


Fig. 2—Sprocket disengaging lower chain and engaging upper chain to reverse direction of shuttle travel

Fig. 2 illustrates the shuttle, which consists of a cast-iron box fitted with removable brass nuts for the reverse levers, chain guides, steel rollers and the reverse sprocket, the last-named having a hardened steel hub plate with five dowel holes so located that one of them will be on the horizontal center line when one pair of sprocket teeth is on the vertical center line.

In the lower view Fig. 1 the right-hand shuttle is traveling toward the left; its left-hand reverse screw is engaged with the dowel hole. In this position the reverse sprocket *A* is locked and the driving chain being engaged with the two lower sprocket teeth carries the shuttle in the direction of the lower run of chain. When this shuttle nears the end of its travel, the left-hand reverse lever *E* comes in contact with the adjustable reverse bracket *D*, throwing the lever and withdrawing the screw dowel from the sprocket hub plate and at the same time extending the coil spring which connects the lower extension of the reverse levers, shown in Fig. 3. This position is shown by the left-hand shuttle in the lower view Fig. 1. As soon as the reverse lever is thrown sufficiently to disengage the sprocket hub plate entirely, the shuttle stops and the reverse sprocket begins to revolve, immediately engaging the top run of chain, as shown in Fig. 2, and continues to revolve until the dowel hole in the sprocket registers with the reverse lever which is forced into place by the coil spring. The upper two teeth are then engaged and the shuttle starts back in the opposite direction.

The hinged yoke *C* is readily disengaged from the spout if it is desired to operate the spout by hand. The machines are made in several lengths and equipped with one or more shuttles to meet installation requirements.

New Induction Motor Has Electric Welded Frame

Through the application of electric-arc welding the Lincoln Electric Co., Cleveland, Ohio, has brought out a new steel-frame induction motor. This replaces the company's older type, which employed cast iron or cast steel in the

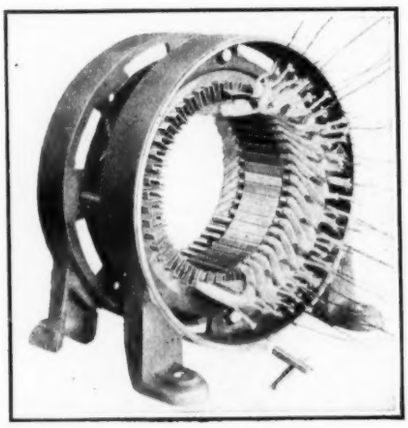


Fig. 1—Stator frame and core with part of the winding in place

frame of the motor. The use of arc welding in the construction of the motor has made possible the replacement of castings with rolled steel and has resulted in a lighter motor for a given output, speed and frequency than when cast frames were used. From Fig. 1 it can be seen that the stator frame is composed of two rings shaped from standard angle iron. The angles are first rolled to circular shape in a machine especially designed for this purpose, and then the ends are welded to form closed circles. After the stator core has been assembled, it is hot-riveted between the two end rings to hold the laminations tightly together and prevent vibration of the stator

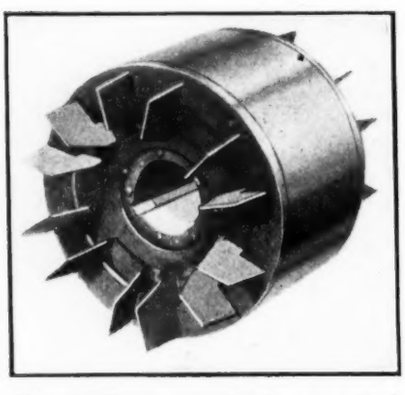


Fig. 2—Rotor completely assembled without the shaft

core. The feet, which are of drop-forged steel, are welded to the angle-iron end rings, as can be seen from the figure.

The rotor's core is assembled and hot-riveted between two steel end plates. Copper bars and end rings constitute the rotors winding. The end rings are made from a bar bent to shape and the two ends welded, after which the rings have holes punched in them for the ends of the bars. The end rings are placed over the ends of the bars and the rotor is placed in a specially designed machine, where the bars and rings are welded together, thus converting the winding into one piece. Forced ventilation is provided for by welding steel vanes on the rotor, as shown in Fig. 2. The effect of these vanes in conjunction with the large space around the end winding allows for a free circulation of air through the various parts of the motor.

Collins Water-Tube Boiler

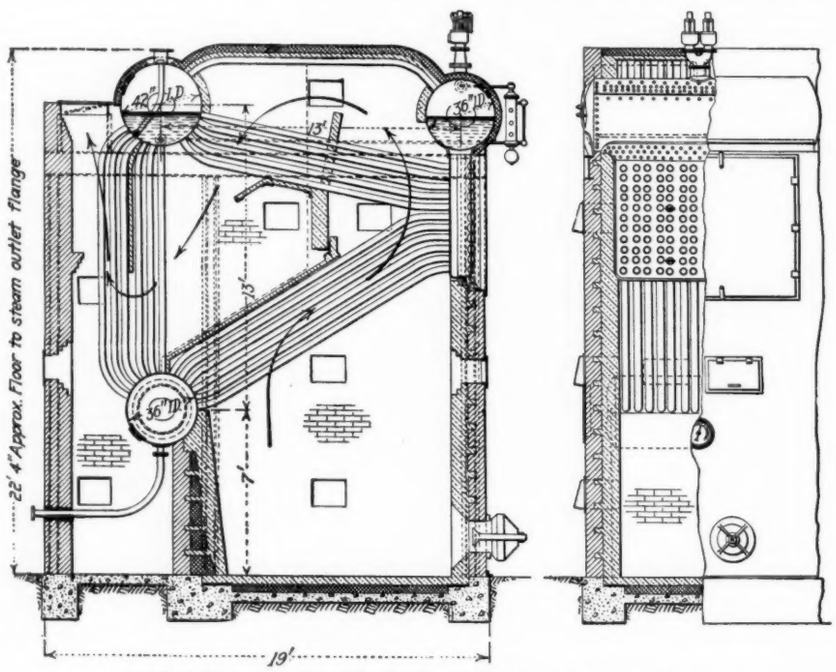
The illustrations show the Collins water-tube boiler brought out during the last year by the Southwestern Engineering Co., Los Angeles, Calif. The boiler is of the curved-tube design and consists of three drums, two upper steam and water drums and a lower suspended mud drum.

The front steam and water drum of the type B boiler is 36 in. in diameter and carries in a vertical position a short water leg of one-piece box construction into which 3½-in. tubes from the mud drum and rear steam and water drum are expanded. The mud drum is connected to the rear upper drum, which is 42 in. in diameter, with the usual curved tubes. The two upper drums are connected in the steam section with one row of equalizing tubes, and it is claimed that the steam in passing through these tubes is raised about 15 deg. above the saturated steam temperature.

The water leg suspended from the front drum and into which two of the three main banks comprising the circulating unit are expanded, permits steam made in the main bank of tubes being taken off in the front drum and then superheated somewhat in passing to the rear drum. This feature it is claimed increases materially the liberating surface of the boiler and eliminates any spouting effect in the discharging of the circulating steam and water into the upper rear drum. The water leg also makes possible the cleaning of the two front banks of tubes from outside the boiler. The tubes are arranged in alternating wide and narrow sets to permit the ready removal of any tubes. The boilers are built to the A.S.M.E. boiler code.

In addition to the stationary boiler just described, which is built in sizes from 800 to 25,000 sq.ft. of heating surface, the company has brought out the Collins portable water-tube boiler known as Type A and built in 800, 960 and 1,120 sq.ft. sizes. It is self-contained, with smokestack, steel casing, steel supports and mountings, is approximately 12 ft. high, 6 ft. wide and 12 ft. long and weighs around 7 tons.

The boiler is suspended from a structural-steel frame and is similar in general design to the stationary boiler shown in the illustration except that the water leg, instead of being suspended vertically, is suspended at right angles to the lower bank of tubes, and the upper bank main tubes are expanded into the front upper drum instead of into the water leg. The front upper drum and mud drum are 24 in. in diameter, while the rear upper drum is 30 in. in diameter, the three being connected by 3-in. tubes.



Section of 2,640-sq.ft. boiler arranged for oil firing

The total exports of electrical energy from Canada to the United States during the fiscal year ended March, 1925, were 1,239,071,297 kw.-hr., a decrease of 57,450,443 kw.-hr. compared with the previous twelve months. Exports during the month of March were 100,159,612 kw.-hr., compared with 118,429,457 kw.-hr. in March last year.

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

IV—Rules for the Prevention of Direct Causes of Boiler Failures

Overpressure

Indicators

Steam Pressure Gages

C-134. A steam gage shall be considered tested when it has been compared and made to agree with a dead-weight testing device or a test gage which has been so tested.

C-135. In order to insure an accurate basis for comparison, the test gage shall be a reliable gage that is used exclusively for testing gages in service and one that is tested and maintained in agreement with a dead-weight testing device. When compensation for the waterleg has been made, an equivalent allowance shall be made in the reading of the test gage or dead-weight testing device.

C-136. Compare the boiler steam gages frequently. Test at times of external inspection, when the boiler is placed in service after periods of shutdown for internal inspection or repairs, and after an extended period of shutdown. When the safety valve pops, note the reading of the gage and if, the reading is not in agreement with the stipulated popping pressure nor with the gages on adjacent boilers operating under the same pressure, test the gage. See the gages are tested when trouble is experienced with boiler compounds, foaming, priming and other feed-water troubles that are apt to cause choking of the gage connections.

C-137. Before testing a steam pressure gage, disconnect it at the gage union and clear the piping, cock and siphon by blowing through. After blowing through, reconnect the gage. Do not admit steam directly into the gage and be sure that at all times the siphon is filled with water. If steam has entered the gage, retest it.

C-138. Keep the gages well lighted at all times and the dials and glass covers clean. See that the glass cover is maintained tight and, whenever the glass is broken, that it is replaced as soon as possible.

C-139. When a boiler steam gage, not in use, is likely to be subjected to freezing temperatures, drain the connections and gage.

C-140. A master steam gage is an auxiliary gage attached to the main header indicating the composite boiler pressure of the whole battery; it is used in the general operation of the plant mainly as a matter of convenience. Master steam gages shall be tested when they are not in reasonable agreement with other reliable steam gages about the plant.

Water Glass

C-141. Keep the communications and valves between the boiler and the water column and the water glass free and clear, and test by blowing down the water column and water glass, noting the promptness of the return of the water to the water column and glass and trying the gage cocks until sure of the water level.

C142. All water columns and water glasses shall be tested by the water tender, or operator directly responsible for the level of the water in the boiler, at the beginning of each shift, and preferably before the relieved shift has gone off duty so that the responsibility for possible low water in the boiler may be determined.

By "shift" is meant a person or group of persons who relieve a person or group of persons in rotation in standing watch or operating a steam-generating plant for an allotted time. It is synonymous with *watch, vigil,* or *tour of duty.*

C-143. Water glasses shall be tested after replacing, and all water glasses on a boiler shall be tested when that boiler is placed in service and when trouble is experienced with boiler compounds, foaming, priming, or other feed-water troubles that are apt to cause choking of the connections.

C-144. Water glasses and their connections shall be kept free from leaks, and no connections allowing a flow of water or steam from the piping between the water column or water glass and the boiler shall be made, as such leaks or flow of water or steam will cause a false indication of the water level in the boiler.

C-145. The outlet end of the discharge pipes from water columns, water glasses and gage cocks shall be kept open and in sight or hearing of the operator while blowing down.

C-146. Water glasses shall be well lighted and kept clean. When they need cleaning, they shall be replaced by clean glasses, as attempts to clean glasses in place lead to possible cracking of the glass or choking from pieces of cloth or waste.

C-147. When a water glass has broken, remove the broken pieces and slowly open the valves to blow out any remaining pieces. Before inserting the new glass, see that the drain is open, that the glass is of the exact length required, and that the connections are in line. Insert the glass with packing and set up the stuffing-box nuts, taking care not to set them up too tight. Then warm the glass by opening the top valve slightly and let a small current of steam flow through the glass. Close the drain cock after the glass is sufficiently warmed, open the bottom valve slightly, and when the level of the water in the glass has become stable, open the bottom valve wide and then open the top valve wide.

Unless the water glass is provided with a guard to protect the operator while replacing water glasses on boilers under pressure, or unless the operator wears a mask or the glass is provided with a suitable guard, the valves shall be operated only by remote control. A suitable water-glass guard may be made in the form of an inverted cone of No. 22 black iron wire screen of $\frac{1}{2}$ in. mesh.

C-148. Where automatic alarms for indicating extreme low water level or extreme high water level are used, they should at all times be kept in good working order. The proper level of water in the glass shall be maintained at all times without waiting for the automatic alarms to indicate unusually high or low water level. When an automatic alarm sounds and the level of the water is not visible in the glass, the operator shall test the gage cocks to determine the water level before manipulating the feed-water valves.

Fusible Plugs

C-149. If fusible plugs are used, see that they are kept in good condition and that they are not used for more than one year as provided for in Par. A-19 of the Power Boiler Section of the Code. When the boiler is open, scrape clean and bright the exposed surfaces of the fusible metal, as well as the surface of the boiler near the plugs. If the fusible metal does not appear sound, renew the plug. Never refill a plug with anything but new metal of a quality specified in Par. A-19 of the Power Boiler Section of the Code.

Relief Equipment

Safety Valves

C-150. Safety valves shall be kept free and clear and in good working condition.

C-151. No safety valve shall be set to pop at a pressure greater than the allowable working pressure of the boiler except as permitted in Par. P-271 of the Power Boiler Section of the Code.

C-152. When boilers are connected into a common steam header and operate under the same working pressure and some of the boilers have allowable working pressures greater than others,

*The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee. On account of the length of the rules *Power* is printing them in short installments, of which this is the fifth.

all safety valves shall be set to pop at a pressure not in excess of that allowed on the weakest boiler unless the lower-pressure boilers are equipped with non-return check valves and sufficient safety-valve capacity is added to the lower-pressure boilers or to the low-pressure header to take care of the capacity of the higher-pressure boilers.

C-153. To insure that the allowable capacity of a safety valve is not exceeded by a change in operating conditions such as when the allowable working pressure of a boiler has been reduced, when a boiler is equipped with increased stoker capacity, or when a change in fuel permits increased combustion, the capacity of the safety valve shall be recalculated, using the requirements given in Pars. P-260 to P-290 of the Power Boiler Section of the Code. If the rules require a greater capacity than exists, the safety-valve capacity shall be increased.

C-154. Never set the popping point of a safety valve above the pressure authorized for the boiler. Where there is more than one safety valve on a boiler, the setting of the popping point of the safety valves shall be in accordance with Par. P-271 of the Power Boiler Section of the Code. If the popping pressure of a safety valve is to be more than 10 per cent above or below the pressure for which the spring is designed, replace the spring with another spring designed for the proper pressure.

C-155. When the spring becomes weak and must be screwed down to secure the stipulated popping pressure, make sure that the spring is not screwed down so far that there is a restriction of the proper amount of opening of the valve as required in Pars. P-282 and P-284 of the Power Boiler Section of the Code.

C-156. Do not allow the setting or adjustment of safety valves by anyone but a competent person. Any setting or adjusting of the blowback ring or any device to regulate this feature, shall be done only by a competent mechanic familiar with the construction and operation of safety valves. Test the safety valve after any setting or adjusting of the spring or blowback ring. Do not have the water in the boiler above the highest gage cock when setting or adjusting the valve.

C-157. In order to insure that the freedom of the spring is in compliance with the Rules given in Pars. P-282 and P-284 of the Power Boiler Section of the Code, it shall be tested whenever the valve spring is adjusted.

C-158. Small chains or wires attached to the levers of pop safety valves and extended over pulleys to other parts of the boiler room may be used.

C-159. Whenever the safety valve pops, the pressure indicated by the boiler gage shall be observed, and when the noted pressure varies more than 5 lb. from the stipulated popping pressure, the boiler gage shall be tested and if found correct, the safety valve shall be corrected. When the working pressure is in excess of 250 lb. per sq.in., the allowable variation in the gage reading shall be 2 per cent of the working pressure.

C-160. When a safety valve sticks or fails to operate at the stipulated popping pressure, no attempt shall be made to free it by striking the body or other parts of the valve but the valve may be opened with the lifting lever, after which the pressure should be raised to the pressure for which the valve is set to pop. If the valve does not then pop, the boiler or the part to which the valve is attached shall be taken out of service and the safety valve cleaned or repaired.

When an additional safety valve is installed on a boiler in excess of the capacity required by the Power Boiler Section of the Code and the capacity of that valve is equal to or greater than the capacity of the faulty safety valve, the boiler may remain in operation until it can be conveniently taken out of service.

C-161. Do not try to stop leakage by tightening the spring or by blocking it in any manner whatsoever. When safety valves leak at a pressure less than that at which they are set to close, repair or replace them as soon as practicable.

C-162. Safety valves shall not be opened to reduce steam pressure in case of low water.

C-163. Care shall be exercised to prevent the accumulation of dirt, scale or other foreign matter between the coils of the spring of the safety valve.

C-164. Keep the drain in the escape pipe open. If the safety valve pops when you are in a favorable position, observe the drain in the escape pipe in order to determine that the drain is unobstructed. When running a wire in a drain hole in the escape pipe to ascertain if it is clear, be careful that the wire does not move scale that may fall over the drain opening when the wire is removed.

C-165. Maintain the proper tension on all supports and anchors to which the escape pipe is attached, and examine them at least once every six months.

C-166. When making a hydrostatic test of a boiler, remove the safety valves and blank the opening, or clamp the valve disks securely to the seats. Also remove the water-column floats if necessary. Make sure that the safety valve is placed in good working condition after the hydrostatic test has been made.

Feed-Water Supply

Rules pertaining to this subject are given under this same heading in Weakening of Structures (Pars. C-185 to C-209).

Excessive Combustion

Damper Regulation

C-167. Where draft-control systems are used, they shall not be considered as relieving the operator of responsibility. He shall be alert at all times to detect unusual conditions which may affect the safety of the structure. Such systems shall be maintained in good condition and be inspected periodically when the boiler is in service and at times of internal and external inspection.

C-168. Do not use any combustibles for igniting a coal fire in such a manner as to cause excessive smoke or possible flareback. Where pulverized coal, gas or oil is used as fuel, make sure that the outlet damper is open to create a light draft before introducing and igniting fuel.

C-169. Where economizers not of integral type are installed with inlet, outlet and bypass dampers, neither the inlet nor outlet dampers shall be closed when the bypass dampers are closed and the boiler is under fire or is being ventilated.

Fuel-Supply Regulation

C-170. Where fuel-control systems are used, they shall not be considered as relieving the operator of responsibility. He shall be alert at all times to detect unusual conditions which may affect the safety of the structure. Such systems shall be maintained in good condition and be inspected periorically, especially where failure of their operation may result in sudden increase of combustion.

Operation

Manipulation of Valves

C-171. Before cutting in a boiler, open and leave open until the boiler is on the line all drains in the connections between the boiler and the main header, especially the open drains between the two stop valves. In general, in cutting in a boiler to a steam header already in service, the steam line between the boiler and the header is usually warmed up by backfeed through the drip line or by means of the bypass valve and the header valve fully opened and the boiler then allowed to cut itself in automatically with the non-return valve. In case a non-return valve is not used, the boiler stop valve should, of course, be opened slowly when the pressure in the boiler and the steam line are approximately equal.

a. With two hand-operated stop valves, open slowly to avoid water hammer to full opening, the stop valve nearer the main header. When the pressure in the boiler is nearly equal to the pressure in the main header, open slowly, to full opening, the stop valve nearer the boiler. After opening each stop valve, stand by for a short period prepared to close the valve in case there is any indication of water hammer.

b. With one hand-operated stop valve and one combined stop and check valve, when the hand-operated valve is nearer the main header, open it slowly and preferably only a small amount at first. Stand by for a short period to close the valve in case there is any indication of water hammer, then open the valve to full opening. When the pressure of the boiler is still 10 to 50 lb. below the pressure in the header, slowly back off the valve stem of the combined stop and check valve sufficiently from the check to provide full opening of the check valve. In order to insure that the check valve functions properly, always use it automatically for cutting in and cutting out boilers, provided that the main header is filled with steam at full pressure.

c. With one hand-operated stop valve and one automatic non-return check valve, open the hand-operated stop valve slowly when the pressure in the boiler is still 10 to 50 lb. below the pressure in the main header and stand by for a short period to close the valve

slowly in case there is any indication of water hammer.

d. If steam is being raised on a boiler not connected to a common steam header, in general it would be more advisable to raise the steam pressure on the whole steam line at the same time, all drips being open.

e. After cutting in a boiler equipped with non-return valves, with two independent outlets, observe the steam pressure in the boiler to make sure that both valves open. If the non-return valve is a combined stop and check valve, operate the rising stem after the steam pressure in the boiler has reached its working pressure in order to ascertain whether or not the valve has opened properly.

A.B.M.A. Committee Advocates Use of A.S.M.E. Suggested Alkalinity Ratio

The committee of the American Boiler Manufacturers Association, appointed last February to report on the phenomenon of "Caustic Embrittlement as it Relates to the Operation of Steam Boilers," submitted a report at the recent meeting of the Association, on the present status of the investigation into this abnormal phenomenon, which was to establish, if possible, preventative measures.

The report in part is as follows:

"The phenomenon of crystallization and cracking of boiler plate at or near the seams—not due to corrosion or wasting away of the plate but rather from some very different action—has been observed and known for upward of 30 years.

"These earlier experiences, wherever studied, were found to be characterized by the fact that: (a) They were experienced in distinct geographical districts; (b) the effect on the plates was in all cases below the water line; and (c) they practically all occurred in boilers using artesian-well water.

"During the last ten or fifteen years more pronounced examples of this trouble have arisen, which have indicated that it may under certain circumstances prove a dire menace to the safety of boilers. In one case a new water-tube boiler drum cracked from end to end, practically its full length, after only six months of use. In other cases it has been found that upon detection of this trouble in one boiler, further examination has revealed that the other boilers in the same plant have been similarly affected and their joint and shell strength greatly reduced. A common indication of this phenomenon of crystallization is the snapping off of rivet heads at the joints affected. The rather mysterious and almost spectacular nature of these troubles has disturbed both manufacturers and users of boilers alike, and the manufacturers of the boiler plate are taking keen interest in the investigations now under way."

Difficulties of this character with boilers have led to investigations by different bodies from time to time and the results have been published in *Power:* In 1912 the University of Illinois at Urbana started an investigation, which was published in Bulletin 94, of the Engineering Experiment Station, 1917, which was conducted by Prof. S. W. Parr; Prof. Henry M. Howe of Columbia University carried out an investigation in 1914; Dr. R. S. Williams and V. O. Homerberg, of the Massachusetts Institute of Technology, made another important investigation; C. E. Stromeyer, chief engineer of the Manchester (Eng.) Steam Users Association, quite recently made an investigation; comprehensive investigations from the chemical standpoint have been made by Stead and Carpenter, reported in the Journal of the Iron and Steel Institute, in 1913; J. H. Andrew, research fellow and demonstrator of metallurgy of the University of Manchester, also investigated this subject. The report adds:

"There has been much speculation as to what recommendation, if any, the Boiler Code Committee of the A.S.M.E. might have to offer in regard to this troublesome phase of boiler operation. The committee gave the problem some consideration, but in view of the lack of authentic data concerning the phenomenon and the incomplete condition of the various investigations now under way upon it, it was found impossible to dispose of the question with any definite recommendation as yet.

"A notation was made by the committee and inserted in the new Section VII of the A.S.M.E. Code entitled, 'Suggested Rules for the Care of Power Boilers,' in which there appears in the Appendix to Feed-Water Analysis, Treatment and Control, the following under Paragraph CA-5:

"Where feed waters contain free soda as bicarbonate, carbonate or caustic, it is recommended to establish a relation between the total alkalinity in the boiler in terms of sodium carbonate and the sodium sulphates as follows:

"For working pressures of 150 lb. and under, alkalinity not to exceed the sodium sulphate; for working pressures over 150 lb. and under 250 lb., alkalinity not to exceed ½ the sodium sulphate; for working pressures of 250 lb. and higher, alkalinity not to exceed ⅓ the sodium sulphate.

"The theory has been advanced that in the absence of sulphates in the boiler water, sodium hydroxide formed in the boiler saline may, by some corrosive action, accelerate the formation of cracks in overstressed material. This theory is based on the following observations: Cracks have been found in leaking riveted seams of a small number of steam boilers fed with natural artesian-well waters high in sodium carbonate and very low in sulphates, and in certain geographical districts in some boilers fed with condensed steam from caustic evaporators, and in some boilers fed with water distilled from sea water to which considerable amounts of sodium carbonate were added. Others contend that such cracks may be entirely explained by faulty material or excessive internal stresses in the plates resulting from the manufacture or the operation of the boiler and by incorrect thermal or mechanical treatment of the plates or by several of these causes combined. Nevertheless the adherents of this theory suggest the maintenance of this sodium sulphate-carbonate ratio stated in Par. CA-5 of the A.S.M.E. Code for the Care of Boilers, in the hope that it will be beneficial and will help to decrease the number of cracks in riveted seams. Whether the control of the sodium sulphate-carbonate ratio will produce the desired results is a matter which experience over a considerable period alone can tell, and CA-5 is therefore suggested, pending the collection of further experience."

Pyrometers for Oil Engines

At the meeting of the Diesel Engine Users Association held in London, England, May 22, a paper by Charles E. Foster on the subject of "Pyrometry of Exhaust Temperatures of Internal-Combustion Engines," was read.

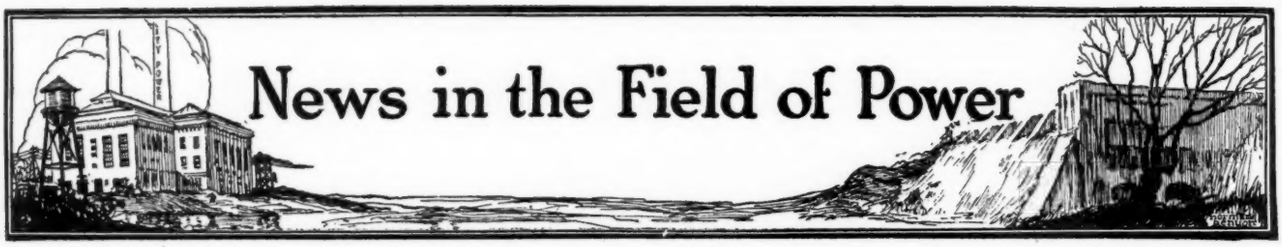
The author said that, quite apart from the undoubted value of exhaust temperature measurement in setting and adjusting an engine on the test floor, it seemed clear that the measurement must be continued in ordinary routine running in order that the operator might have the earliest intimation of impending trouble.

The paper covered more particularly the design, arrangement and operation of the pyrometer itself, the speaker stating that it was axiomatic that the more the engineer understood of the principles upon which pyrometers were constructed the better he would be able to select and use the apparatus.

There are two main types of pyrometer, the first consisting of a thermo-electric couple in which the heating of a junction between two dissimilar metals or alloys generates an electric current which is the actual means of measurement; the second type consists of a resistance thermometer in which the change in electrical resistance of a coil of fine wire, due to change in its temperature, is the means of measurement; the latter class requires an external source of current such as an accumulator. For certain reasons the resistance thermometer type has certain disadvantages rendering it less suitable for the particular work in question. In this instrument the sensitive part, which must be raised to the temperature of the exhaust gases, is a coil of fine wire mounted on some form of insulated bobbin. It is obvious that the mass and thermal capacity of such a resistance coil and bobbin is greater than that of a simple thermocouple junction, and since it is essential to inclose the resistance coil in an outer sheath, the time lag and conduction error may be greater than that of the worst design of thermocouple.

A third type of pyrometer was mentioned—the expansion pyrometer, in which a bulb containing mercury under pressure is connected by a fine-bore capillary tube to a Bourdon pressure gage calibrated in temperatures. It is not safe to use an expansion pyrometer of this type over about 750 deg. F., and in addition, it involves a separate indicating dial to each exhaust pipe.

The thermocouple was considered by the speaker to be the correct type of instrument, and the instrument industry has now placed in the hands of users of heavy-oil engines the means of measuring easily and regularly temperatures that are known to have a vital connection with the performance and life of the engine.



Patent Office Procedure Committee Considering Various Phases

Questions of Working Clause—Separation of Adminstrative and Legal Functions—Huge Labor Turnover—Housing Discussed

THE working clause invariably comes up for some discussion at the meetings of the Committee on Patent Office Procedure, although questions of administration are the principal subjects discussed. The working clause is particularly interesting at this time as two of the committee will be members of the American delegation which will attend the International Conference at The Hague in September.

New Legislation Suggested

Among other views that have been submitted to the committee is that of the chemical industry to the effect that provisions should be made whereby those who hold American patents and who prefer to co-operate under them in the foreign countries, rather than in our country, should be compelled to grant a license or work them here. It is proposed that legislation provide "that two years after the issuance of any United States patent hereinafter granted, or at any time after the expiration of that period, if it is shown that the invention covered by such patent is being worked in a substantial manner in a foreign country by the patentee or by others deriving the right from him and that the owner thereof has not only failed to work it in a substantial manner in the United States, but has refused or refuses to grant licenses thereunder, upon such reasonable terms as would make it practicable to practice the invention in the United States, then on the petition of any reputable American citizen, corporation or partnership, exclusive jurisdiction is thereby granted to any United States Circuit Court of Appeals to investigate all appurtenant facts." The object would be to require the patentee to work or grant a license in the United States.

The question also is raised if we would not gain by requiring claims to be published in advance of the granting of patents and would it not be fair to require applicants, in cases of reasonable doubt, to demonstrate before a competent committee the facts that a careful adherence to the directions of the patent would produce the product claimed? While some of these points bear more on the chemical industry than upon other activities, it is contended that something should be done to prevent foreigners from using our patent system to hinder rather than to encourage industry.

Intensive work is being done by L. W. Wallace, W. H. Leffingwell and Wallace Clark, of the committee's engineering subcommittee, on the administrative side of the work, and the subcommittee has reached the conclusion that a sharp line of demarkation must be drawn between the administrative functions of the office as distinct from the judicial and legal side. The subcommittee will recommend that an assistant commissioner, or comparable official, working under the direct supervision of the Commissioner of Patents, be vested with responsibility for the administrative conduct of the bureau. Another recommendation is that the law be amended so that the chief clerk need not be an examiner. It is in the interest of good administration, experience has shown, to reduce as much as possible any changes of that official. The frequent changes in the office of chief clerk of the Patent Office are held to be due to the fact that an examiner usually is restive under administrative responsibilities. He prefers to return to his professional work as an examiner. The subcommittee is convinced that the shortcomings in Patent Office administration can be traced directly to the mixing of judicial and administrative functions.

Large Turnover of Technical Force Unsatisfactory

An analysis of personnel turnover made May 1 of this year shows that in the technical divisions of the Patent Office 27 per cent of the staff serves less than one year; 54 per cent serves less than four years, and 74 per cent serves less than ten years. The subcommittee in its report will point out that such a turnover among the technical employees in an industrial concern would disrupt its business. Better pay and the establishment of a training school for new employees will be suggested as measures calculated to reduce the turnover.

New Buildings Considered Necessary

One essential to increased efficiency, in the opinion of the subcommittee, is proper housing. The subcommittee is convinced that no adequate solution of the Patent Office problem can be arrived at until the Bureau is housed in a building designed for its use and the obsolete office equipment is replaced with that especially constructed for the needs of such an activity.

Recession of Niagara Falls To Be Verified by Maps

Within a month an accurate idea of the rate of recession of the crest line of Niagara Falls will be available. The army air service recently carefully photographed the entire crest line. Maps now are being made from these photographs. These maps will be compared with one made in 1917. Airplanes were not used in making the 1917 map, and it is realized that it is not as accurate as the map of the crest made from the air, although particular efforts were put forth to get the best possible results at the gorge of the horseshoe. The comparison is expected to establish the approximate amount of recession since 1917. This will make possible an estimate of the length of time it will take Niagara Falls to commit suicide, as one engineer has described it.

Two Trade Statistics Cases To Have Rehearing

In announcing his intention to file petitions for rehearings in the Maple Flooring and Cement Manufacturers' Protective Association cases, the Attorney General made it clear that he is in no way challenging the principles laid down by the court, but simply is attempting to show that there was violation of law in these particular instances. The Attorney General's statement follows:

"Petitions for rehearing in these cases are in course of preparation and will be presented to the Solicitor General within a few days. Leave was granted by the Supreme Court on June 8 to file such petitions within 30 days.

"The object of the petitions will not be to obtain a reconsideration of the principles of law annunciated by the Supreme Court in its recent decisions, but to point out that the evidence in these cases brings them within prior decisions of the Supreme Court, the authority of which has not been questioned. In other words, the government will not take the position that the Supreme Court erred in holding that the mere collection and dissemination of trade statistics is in itself unlawful, but will endeavor to point out that the evidence in the records shows that both the Maple Flooring Association and the Cement Association were co-operating in the use of such information for maintaining prices.

"The whole effort will be to show that the evidence leads irresistibly to the conclusion that the defendants, through their associations, had agreed to maintain prices and otherwise restrain trade within the prior decisions of the Supreme Court in the Hardwood Lumber and Linseed Oil cases."

Glines Canyon Project To Start Construction Aug. 1

The Northwestern Power & Light Co. of Port Angeles, Wash., has been granted a permit to appropriate water from the Elhwa River on the Olympic Peninsula for the operation of a hydro-electric plant. A development of 10,227 hp. under a head of 150 ft. is to be made at a cost of approximately $800,000. A concrete diversion dam 160 ft. in height will impound 150,000 acre-feet of water. The principal consumer of the power company is the Washington Pulp & Paper Co. at Port Angeles, Wash. Transmission lines extend as far as Bremerton, Wash., where service is supplied to the Government Navy Yard. Construction on the new plant, which is known as the Glines Canyon project, is to begin by Aug. 1, 1925, and is to be completed by Dec. 31, 1926.

Tennessee River Survey Progressing

Power producers on the Tennessee River and those contemplating developments on that stream or its tributaries, are co-operating closely with the Corps of Engineers in the $500,000 survey being made of that basin. As a result of this work, it is declared, the haphazard development of the power resources of the region by unrelated private interests will be avoided and a carefully co-ordinated plan put into effect which will make it possible to utilize the maximum resources of the streams.

By the use of airplanes the maps that are being prepared contain a wealth of detail that was not contemplated in the original plans. The success that has followed this method of mapping in the course of the Tennessee survey apparently will insure its use in connection with the surveys of other rivers which are contemplated by the Corps of Engineers and the Federal Power Commission.

University of Pennsylvania Changes Engineering Course

A minimum of two years' study in college is to be required by the University of Pennsylvania for entrance to its mechanical, civil and electrical engineering schools, effective next autumn. This innovation will make the requirements for entrance to the engineering school similar to those of the law and medical schools in the University.

A two-year course in engineering will be given, leading to a degree of bachelor of science, but students may also take a three-year course leading to a degree of master of sciences.

The trustees of the Moore School presented the plan. They explained that the new arrangement will permit the trust fund from the Moore estate to be applied more directly to instruction in engineering, eliminating the present system of having engineering students occupy their first two years with cultural subjects. They also point out that the new plan will reduce the number of students who leave the engineering schools in the four-year term. By actual experience, it is stated, approximately one-third of all students who enter the course in electrical engineering drop out before the end of the second year.

The Moore School trustees also mention that the two-year preliminary training in college will permit the student subsequently to make a wiser choice of the engineering field he wishes to enter, and further that a student who finds his interest in engineering waning may go on with his regular college course and the Moore trust fund will thus be saved the present expense of affording instruction to prospective engineers who may not decide to follow that profession.

C.A.S.E. Holds Annual Meeting at Windsor

The thirty-sixth annual convention of the Canadian Association of Stationary Engineers, Inc., was held at Windsor, Ont., on June 23 to 25 with headquarters at the Prince Edward Hotel. In connection with the convention there was a large exhibition of power equipment and supplies in the Armories. The exhibition was well patronized during the convention both by the delegates and by engineers and superintendents from the many factories in Windsor and the adjacent towns of Sandwich, Walkerville and Ford. There were about forty delegates constituting the Grand Lodge.

The meetings opened Monday night, June 22, for the appointment of committees on finance and resolutions and auditors. Robert McLaren, president, presided. He also presided at the Tuesday morning business session, when several matters of importance were discussed. The treasurer's report showed that the association's finances were in good shape. Several lodges reported increases in membership. These were Hanover, Stratford, Toronto which had an increase of 33 per cent, Windsor of 42 per cent and Leamington of 64 per cent. Alderman C. D. Fraser, of Windsor, acting mayor, welcomed the engineers to Windsor.

Under the direction of the Border Cities Chamber of Commerce the engineers were taken to the Ford plant at Ford, Ont., for a trip through the factory. On their return the fire brigade gave a demonstration of the new fire-fighting apparatus.

At the Tuesday night session a committee was appointed to look into the questions of sick benefits and were asked to report at the Thursday afternoon session. The following officers were elected: Past-president, Robert McLaren, Toronto; president, Fred A. Pflug, Kitchener; vice-president, W. Turnbull, Windsor; secretary, George Brown, Toronto; treasurer, H. E. J. Groome, Kingston; conductor, Tom Shrimpton, Woodstock; doorkeeper, D. L. Webster, Leamington.

All day Wednesday was spent picnicking. The engineers left by boat for Bois Blanc, where a long list of athletic events were enjoyed. In the tug-of-war, which was the main event, the supplymen won from the "stationary" engineers.

The annual banquet was held at the Prince Edward Hotel in the evening. There were a number of excellent speeches, among them being one on "Service," by William T. McGee, chief engineer of the Ford Motor Co. of Canada; "Citizenship," by the chief engineer of Windsor, "Relationship of Employers and Employee," by Robert McLaren. Mr. McLaren pointed out that employees owed an obligation to their employers as well as employers to their employees. Earl F. Hetherington conveyed the good wishes of the supplymen to the engineers.

At the Thursday morning session a resolution was passed regretting the passing of the executive secretary, George Soucy, and it was decided to pay his salary to the end of the uncompleted term.

Edward J. Everett, of the Stationary Engineers' Board, addressed the convention on the work of the Board in answering many letters which had been addressed to the Board by members. It was then decided that all complaints sent to the Stationary Engineers' Board, the Boiler Inspection Department or the Factory Inspection Department be sent through the executive secretary. This will assist in greater co-operation between the association and the government departments.

A resolution was passed strongly approving of the proposed act for the annual inspection of boilers as drawn up and discussed last spring by representative bodies.

At the afternoon session a report was made by the committee on sick benefits and it was decided to devise a plan of insurance for engineers giving both death and sick benefits. The following were elected trustees to carry out the plan: Campbell Bradshaw, chairman; George Brown for six years; George Galloway for five; F. A. Pflug for four; H. Webster for three; R. McLaren for two years; W. Turnbull for one year.

London was selected as the next place of meeting, the last week of June, 1926, the Mayor, Council and Chamber of Commerce giving pressing invitations by telegraph.

Petroleum Institute's Oil Supply Report Complete

The American Petroleum Institute's Committee of Eleven completed its report on June 28, on the national oil supply. The report is to be submitted to President Coolidge before being made public. Indications, according to the press, are that it will show that there is no cause for alarm concerning any oil shortage in this country in the near future.

Bureau of Mines Turns Back Oil Shale Funds

A balance of approximately $34,000 out of an appropriation of $100,000 to the Bureau of Mines for studies of lignite and peat was returned to the United States Treasury on July 1. The original appropriation was made in 1919. The Bureau of Mines reports the completion of its work as outlined in the act and that studies of the utilization of lignite and peat will be outlined in reports now in process of being printed.

$100,000,000 To Be Spent by Philadelphia Co.

In connection with the ceremonies of dedication of the new building of the Philadelphia Company, Pittsburgh, a notice of which appeared in *Power* June 30, 1925, page 1052, an announcement was made by Arthur W. Thompson, according to the press, that a program calling for the expenditure of $100,000,000 in the next five years has been approved by the directors of the Philadelphia Co., which controls a large number of public utilities in western Pennsylvania and West Virginia.

Only Two Bids for Muscle Shoals Temporary Power

Apparently, the Southern power companies are the only ones interested in the purchase of such power as may become available at Muscle Shoals during the testing of the main generator units and waterwheels. Only two replies have been received by the Chief of Engineers within the time limit set for replies to his letter. One reply was from the Union Carbide Co. stating that it would not be interested in the purchase of power under the conditions outlined. The other reply was from the Alabama Power Co. on behalf of the associated companies which will make use of its power.

First Feather River Plant To Be 60,000 Hp.

Signing of a contract for the sale of the output of the Bald Rock power plant of the Feather River Power Co. to the Great Western Power Co. assures the early construction of a 60,000-hp. hydro-electric plant in northern California. The plant will be the first of six in a development that will produce 400,000 hp., costing between $45,000,000 and $50,000,000.

The plant now to be constructed will be located at Buck's Creek on the Middle Fork of the Feather River, a short distance above the Las Plumas plant of the Great Western Power Co. It will contain two units operating under a head of 2,580 ft. A dam across the Feather River will create a storage reservoir of 110,000 acre-feet capacity. The Great Western Power Co. will take delivery at the power house on the high side of the transformers.

The Feather River Power Co. is now waiting for release of its permit by the Federal Power Commission.

Hetch Hetchy Power Sale Again Protested

While San Francisco is doing all it can to expedite execution of a contract to dispose of Hetch Hetchy power temporarily through the lines of the Pacific Gas & Electric Co., the Modesto Irrigation District has filed protest with the city and the Secretary of the Interior against such sale. Modesto's action is taken on the grounds that the proposed contract is a violation of the Raker Act, under which San Francisco is developing water and power, and that it does not properly provide for the needs of the irrigation district as required by the Raker Act.

On the other hand, those who are familiar with the situation in San Francisco claim that the irrigation district has no grounds for protest because the proposed contract with the Pacific Gas & Electric Co. specifically provides that the company will receive the output of the Moccasin plant, diminished only by losses and city needs, "and also by such amounts, if any, as the city may be legally required to furnish to irrigation districts or municipalities under the Raker Act." In the meantime official representatives of the City of San Francisco are in Washington conferring with government officials as to the legality of the contract.

Public vs. Private Ownership and Operation Debated

Public versus private ownership of public utilities was discussed at Camp Tamiment near Bushkill, Pa., on June 27, by Morris Hillquit, Socialist leader, and Arthur Williams, vice-president of the New York Edison Co., at a conference conducted by the League for Industrial Democracy.

Mr. Hillquit asserted that public utilities are by their very nature quasi-public institutions and that their business is a public function. He declared that the first and most cardinal distinction between the two systems is that private ownership and management is undertaken and conducted primarily for private profit, while public ownership and operation are primarily instituted for the public good.

Mr. Williams declared that the idea that property may be eliminated by the condemnation of private property is a delusion supported by the misapprehension of the motives inspiring private ownership and of the results attainable by public administration.

Mr. Hillquit said: "The main tests of the comparative merits of the two systems may be enumerated under the following heads: The cost of service; its quality; position of employees; the effect on public life. On all of these tests public ownership proves itself superior."

Mr. Williams questioned the statement that rates in Ontario were lower than in New York City.

Personal Mention

Louis C. Whiton, president of Prat-Daniel Corporation, of New York City, sailed on the "Mauretania" recently for a visit to Paris.

Paul S. Reinecke recently appointed assistant chief engineer of the Federal Power Commission, has arrived in Washington and has entered upon his new duties.

Charles S. Ruffner, vice-president and general manager of the Adirondack Power & Light Corp, has been elected president of the Mohawk-Hudson Power Corporation.

John Gaillard, who has been engaged for some time in standardization work for the American Radiator Co., has returned to the service of the American Engineering Standards Committee as engineer on the staff.

Major Glenn E. Edgerton, chief engineer of the Federal Power Commission, is making an inspection visit to the Tennessee River projects which have applications before the Commission. His trip will include a visit to Muscle Shoals.

John E. Schurch, vice-president of Manning, Maxwell & Moore, of Chicago, manufacturers and distributors of industrial equipment, has been selected as president of the company to succeed J. M. Davis, recently chosen president of the Delaware, Lackawanna & Western Railway Co.

Obituary

Herbert S. Valentine, inventor of the Lo-Hed hoist, manufactured by the American Engineering Co., of Philadelphia, died at his home there on June 5, as the result of septicemia following erysipelas that developed on a Western business trip. Mr. Valentine had been a designer and manufacturer of hoists for more than twenty years and had been connected with a number of leading manufacturers in this line, holding important engineering and executive positions. He was one of the organizers of the Standard Electric Crane & Hoist Co., of Philadelphia, and was chief engineer with that company when it was taken over in 1922 by the American Engineering Co. At the time of his death he was sales manager of the monorail hoist department of the American Engineering Company.

Society Affairs

The Institute of Metals, G. Shaw Scott, 36 Victoria St., London S.W.1, will hold its annual autumn meeting in Glasgow, Scotland, Sept. 1-4. The fourth Autumn Lecture will be delivered by Sir John Dewrance, vice-president. This is the first meeting in fifteen years to be held in Scotland, and many visitors from America and Canada are expected.

The American Engineering Standards Committee has been requested by the A.S.M.E. to authorize the organization of a sectional committee whose duty it would be to develop standards for drawings and certain drafting-room practices, which the committee has signified its willingness to do. The A.S.M.E. has also asked that the A.E.S.C. take up the standardization of graphs, and the latter has authorized the appointment of a representative special committee to consider the questions of sponsorship and scope.

The Iowa State Association of the N.A.S.E. at its recent convention in Ottumwa elected officials for the coming year as follows: President, I. C. Lowe, No. 9, Cedar Rapids; vice-president, Frank J. Parks, No. 7, Davenport; secretary, Royal H. Holbrook, No. 9, Cedar Rapids; treasurer, J. A. Coulson, No. 8, Sioux City; conductor, William Hughes, No. 15, Keokuk; doorkeeper, Hans Peterson, No. 11, Marshalltown; state deputy recommended, Clyde A. Bland, No. 2, Des Moines. The convention for 1926 will be held in Cedar Rapids; for 1927 in Davenport and for 1928 in Ames at Iowa State College.

Business Notes

The Chase Companies, Inc., Waterbury, Conn., manufacturers of condenser tubes, rods, etc., announce that they will move the New York City office of the Chase Metal Works and the Waterbury Manufacturing Co., to 138 Lafayette St., about July 1.

The Engineers Co., 17 Battery Place, New York City, experts in baffling boilers with the Turner baffle, combustion control and oil-burning equipment, announces that it is opening an office at 760 Broad St., Newark, for the handling of the same equipment. The Newark office is to be in charge of Frank Beers.

The International Combustion Engineering Corp., through its subsidiary the Combustion Engineering Corp., New York City, has received a contract from the New York Edison Co. amounting to nearly $1,000,000 for pulverized-fuel-burning equipment installations in its Fourteenth Street Station, New York City. The contract calls for the installation of water-cooled furnaces, air preheaters and air transport systems.

The Conveyors Corporation of America, manufacturers of coal- and ash-handling equipment, announces that its district representative in Minneapolis, the Kent Engineering Co., has removed its office to 716 Builders Exchange Bldg., Minneapolis, Minn.; the appointment of the Chicago Electric Co., 740 West Van Buren St., Chicago, Ill., as district representative for northern Illinois and northern Indiana.

The Advance Machinery & Supply Co., manufacturers of "Advance" stoker and "Advance" soot blower, Railroad Bldg., Denver, Colo., announces that George A. Muir, who has been connected with the Denver office of the Allis-Chalmers Manufacturing Co. for the last five years and for ten years previous with the Mine & Smelter Supply Co., Denver, has been elected president and manager of the company. This company represents in Denver the following manufacturers: The DeLaval Steam Turbine Co., Trenton; the Yarnall-Waring Co., Philadelphia, Pa.; the Richardson-Phenix division of the S. F. Bowser & Co., Fort Wayne, Ind.; the Betson Plastic Fire Brick Co., Rome, N. Y.; the "S-C" Regulator Manufacturing Co., Fostoria, Ohio; the Heine Chimney Co., Chicago, Ill.; the Uehling Instrument Co., Paterson, N. J.; the Viking Pump Co., Cedar Falls, Ia.

Trade Catalogs

Megohmer—Herman H. Sticht & Co., 21 Park Row, New York City. Bulletin No. 130 describes the model "D" Megohmer manufactured by Siemens & Halske.

Thermometers, Recording—The Bristol Company, Waterbury, Conn. Catalog No. 1303 describes these gas filled recording thermometers for temperatures between 60 deg. below zero and 1,000 deg. F. There are many illustrations of the different models, and lists of charts included as well as a price list.

Valves—Mesta Machine Co., Pittsburgh, Pa. Bulletin "D" describes these automatic plate valves (Iversen patents) which are adaptable for use on compressors, blowing engines, pumps, etc.

Coming Conventions

American Ceramic Society. Ross C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Trip starting at Rochester, N. Y., then to Montreal, Quebec, back to Niagara Falls or Hamilton, July 4-11.

American Chemical Society. Charles L. Parsons, 1709 G St., N. W. Washington. Meeting at Los Angeles, Aug. 3-8.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Summer meeting at Salt Lake City, Utah, July 8-10.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City Nov. 30-Dec. 3.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Gas Products Association, Charles T. Allen, 140 South Dearborn St., Chicago, Ill. Eleventh annual convention at "The Grand," Mackinac Island, Mich., July 21-23.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Michigan Association** at Muskegon, July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Universal Craftsmen Council of Engineers. Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Twenty-third international convention in the Armory, at Akron, Ohio, August 3-8.

Gages—Defender Automatic Regulator Co., 308 South 8th St., St. Louis, Mo. Bulletin No. 25 describes gages adapted for stokers, hand-fired boilers, pulverized fuel and oil-burning equipment.

Starters, Automatic — Electric Machinery Manufacturing Co., 14th and Tyler Sts., N.E., Minneapolis, Minn. Bulletin No. 799 describes automatic starters for synchronous motors. Principles of operation, and illustrations of oscillograms of currents, are given, as well as pictures and drawings of the starters.

Packing—The Garlock Packing Co., Palmyra, N. Y. Catalog A-1925 just issued by the company, is a good example of a reference catalog. In book form, 176 pages, the company's packing products for all purposes, are described and illustrated with photos and drawings. As it also contains numerous tables of engineering data and convenient memorandum sheets, it will undoubtedly find a permanent place in the busy executive's bookcase.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	June 29, 1925
Pool 1	New York	$2.40@$2.75
Smokeless	Boston	1.57
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.00@ 1.25
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.60

FUEL OIL

New York—July 2, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis — June 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—June 25, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—June 29, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia — June 25, 28@30 deg., $2.21@$2.273 per bbl.; 18@22 deg., $1.974@$2.037; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—June 29, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4⅝c. per gal. light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati — June 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5⅞c. per gal.

New Plant Construction

Ark., Lepanto—Bd. of Comrs., will receive bids until July 9th for the construction of waterworks and distribution systems, including pumping equipment, mains, etc. Estimated cost $46,800. T. H. Allen, Bank Com. Bldg., Memphis, Tenn., is engineer.

Calif.—State has appropriated funds for the construction of a boiler plant and equipment $64,835 also cold storage plant equipment $13,173 for Pacific Colony at Pomona, boiler plants and equipment for State Teachers' College, San Francisco, $35,000 and the Mendocino State Hospital, Ukiah, $49,000. B. G. McDougall, Forum Bldg., Sacramento, is state architect.

Calif., Berkeley—Central Berkeley Building Co., c/o W. H. Ratcliff, Jr., Mercantile Bank Bldg., Archt., will build a 12 story office and stores building at Center and Shattuck Aves. Estimated cost $500,000. Work to be done by separate contracts under supervision of architect.

Calif., Fresno—Fresno County, D. M. Barnwell, Clk, is having plans prepared for the construction of a boiler plant at county hospital. Estimated cost $50,000. C. E. Butner, Cory Bldg., is architect.

Calif., Los Angeles—H. H. Abernathy, c/o L. L. Jones, Grosse Bldg., Archt., is having plans prepared for the construction of a 14 story apartment on La Brae Ave. Estimated cost $650,000.

Calif., Los Angeles—M. J. Nayden, 1212 South Serrano St., awarded contract for the construction of a 14 story apartment on North Cherokee St. to A. T. Hesse, Union Oil Bldg. Estimated cost $750,000.

Calif., Oakland — Latham Square Corporation, c/o M. I. Diggs, 17th St. and Telegraph Ave., Archt., is having plans prepared for the construction of a 14 story office and stores building at 16th St. and Telegraph Ave. Estimated cost $1,000,000.

Calif., Oakland—J. K. Leaming, c/o W. H. Weeks, 1924 Broadway, Archt., is having plans prepared for the construction of a 10 story hotel at 19th and Franklin Sts. Estimated cost $1,500,000.

Calif., Palmdale — Palmdale Irrigation Dist., G. A. Pyle, Secy., will receive bids until July 10th for furnishing a pump to lift water from depths varying from 100 to 700 ft. District retains right to increase number of pumps at price bid.

Calif., Redwood City—W. A. Price, Clk., is in the market for 1,000 g.p.m. booster type centrifugal pump direct connected to 75 hp. motor.

Calif., San Francisco — Marian Realty Co., 1179 Market St., plans the construction of a theatre and office building at 8th and Market Sts. Estimated cost $2,500 000. Rousseau & Rousseau, 1179 Market St., are architects.

Colo., Denver—Tremont Investment Co., c/o G. M. Musick, Foster Bldg., Archt., awarded contract for the construction of a 12 story office building at 16th and Tremont Sts. to Dutton-Kendall Co., 2161 Broadway. Estimated cost $1,650,000.

Conn., Bridgeport—R. Williams, 1838 Whitney St., Hamden, Archt., is receiving bids for the construction of a 6 story apartment on North End St. here. Estimated cost $1,000,000.

Conn., Norwich—The state legislature has appropriated $226,700 for additional buildings, also making improvements to power house for Norwich State Tuberculosis Hospital here.

D. C., Washington—Bureau of Yards and Docks, Navy Dept., will receive bids until July 15th for the construction of addition to boiler house.

D. C., Washington—The Cosmopolitan Hotel Co., will receive bids about July 15th for the construction of a 9 story hotel at 13th and H Sts. N. W. Milburn, Heister & Co., Union Savings Bank Bldg., are architects.

D. C., Washington—H. A. Flint, Gen. Purch. Officer for the Panama Canal, will receive bids until July 15th for one 750 r.p.m., d.c. generator compound wound with commutating poles.

Ill., Granite City—Sisters of Divine Providence, c/o St. Elizabeth's Hospital is having preliminary plans prepared for the construction of a 3 story hospital on Madison St. Estimated cost $500,000. Architect not selected.

Ill., Joliet—Guardian Angel Orphanage, awarded contract for the construction of a 3 story orphanage, including a boiler house, etc., to Immel Construction Co., Dana Bldg., Fond du Lac, Wis. Estimated cost $350,000.

Ill., South Beloit (Beloit, Wis., P. O.)—Freeman Shoe Mfg. Co., 300 St. Paul Ave., Beloit, Wis., is receiving bids for the construction of a 3 story factory, including a 20 x 40 ft. boiler room here. Estimated cost $85,000. H. J. Esser, 82 Wisconsin St., Milwaukee, is architect.

Ill., Staunton—City is having preliminary plans prepared for the construction of a waterworks, including dam, reservoir, filter plant, pumping equipment, etc. Estimated cost $200,000. W. A. Fuller Co., 1917 Railway Exchange, St. Louis, Mo., is engineer.

Ill., Venice—City will soon receive bids for the construction of a sanitary sewer system including pumping plant on the Mississippi River. Estimated cost $250,000. Shepard & Morgan, Edwardsville, are engineers.

Ind., Anderson—City plans the improvements to electric light plant, including new generators, condensers, etc. Estimated cost $15,000.

Md., Baltimore—Standard Electric Machinery Co., 9 East Hill St., is in the market for 125 hp. 3 ph. 60 cy., 440 v. 600 to 900 r.p.m. slip-ring motor with drum or multiple switch starter.

Mass., Boston—The Knickerbocker Ice Co., 41 East 42nd St., New York, plans the construction of an ice plant on Albany St., here. Estimated cost $100,000. C. L. Wier, c/o owners, is architect.

Mass., Boston—Statler Hotel Co., 33rd St. and 7th Ave., New York, will soon receive bids for the construction of a 14 story hotel at Columbus Ave., St. James Ave. and Province St., here. Estimated cost $4,000,000. G. B. Post & Co., 101 Park Ave., New York, are architects.

Mass., Sommerville (Boston P. O.)—New England Vinegar Works, Inc., awarded contract for the design and construction of a 3 story manufacturing building, including a boiler house, to Lockwood, Greene & Co., 24 Federal St., Boston, Engrs.

Miss., Hernando—City, S. W. Eason, Clk, will receive bids until July 20th for furnishing and erecting one 1510 Lutwiler pumping engine, double stroke, non-pulsating, maximum capacity 5,800 g.p.h. against 230 ft. head, one 7½ hp. 220 v. 3 ph. general electric motor, one 10 hp. Fairbanks-Morse engine, type Z or equivalent.

Mo., Buffalo—City plans an election July 20 to vote $40,000 bonds for deep well, tank on tower, pumping equipment and mains. Russell & Axon, McDaniel Bldg., Springfield, are architects.

Mo., St. Louis—P. Brown, c/o I. T. Cook, Arcade Bldg., is having plans prepared for the construction of a 10 story addition to office building at 9th and Pine Sts. P. J. Bradshaw, International Life Bldg., is architect. A. Monschein, 1727 Arcade Bldg., is engineer.

N. Y., New York—J. C. & M. G. Mayer, 347 Madison Ave., plans the construction of a 35 story office building at 42nd St. and Lexington Ave. Estimated cost $8,000,000. Architect not selected.

N. Y., St. George, S. I.—The Staten Island Edison Corporation, awarded contract for the design and construction of a 9,000 ft. conduit line containing two 33,000 v. cables along the north shore on the Baltimore and Ohio right-of-way from Livingston power house west of Livingston Ave., a combined substation including apparatus for both lighting and railroad service to J. G. White Engineering Corporation, 43 Exchange Place, New York.

Neb., Lincoln—Eppley Hotel Co., is having plans prepared for the construction of a 10 story hotel at 11th and P. Sts. Estimated cost $750,000. H. L. Stevens Co., 30 North Michigan Ave., Chicago, Ill., is architect.

O., Cleveland—American Steel & Wire Co., J. N. Fleming Purch. Agt., Rockefeller Bldg., awarded contract for the construction of a boiler house on Cuyahoga River to American Bridge Co., Rockefeller Bldg. Estimated cost $300,000.

O., Cleveland—City will receive bids until July 10th for a turbo generator and switchboard. G. Beackwith, City Hall, is engineer.

Okla., Lawton—Southwestern Light & Power Co., plans the installation of a large cooling system, and a 5000 k.w. generator, etc. Additional boilers will be purchased.

Pa., Hanover—W. L. Stoddard, 50 East 41st St., New York, Archt., will receive bids until July 10th for the construction of a 5 story hotel for Community Hotel Co. here. Estimated cost $500,000.

Pa., Philadelphia—Dept. Public Health, W. Krusen, Director, City Hall, will receive bids until July 21st for the construction of a hospital at 34th and Pine Sts. Estimated cost $4,000,000. P. H. Johnson, 1713 Sansom St., is architect.

Pa., Philadelphia—Pennsylvania R. R., Broad St. Station, A. C. Shand, Ch. Engr., is having plans prepared for the construction of a 14 story office building at 32nd St. and Lancaster Ave. Estimated cost $3,300,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., are architects.

Pa., Philadelphia—C. W. Rudisill, c/o W. H. Lee, 1505 Race St., awarded contract for the construction of a garage and service building, including a boiler house at King St. and Queen Lane, to Nelson Pedley Co., Corn Exchange Bank Bldg. Estimated cost $70,000.

Pa., Pittsburgh—The Montefoire Hospital, 300 Center St., is having plans prepared for the construction of a hospital at 5th Ave. and Darragh St. Estimated cost $1,000,000. Schmidt, Garden & Martin, 104 South Michigan Ave., Chicago, Ill., are architects. H. Hornbostel, Century Bldg., is associate architect.

Pa., Pittsburgh—Shriners National Hospital Fund, S. P. Cochran, Pres., 1821 Young St., is having plans prepared for the construction of a children's hospital on Stanton Ave. Estimated cost $600,000. Hentz, Reed & Adler, Candler Bldg., Atlanta, Ga., are architects.

Pa., Upper Darby (Philadelphia P. O.)—M. P. Levy, awarded contract for the construction of a 4 story apartment on Westchester Road and Briefar St. to Boyle-Robertson Co., 16th and Harvard Sts. N. W., Washington, D. C. Estimated cost $800,000.

S. C., Leesville—Bd. of Comrs., C. D. Barr, Jr. Chn., will receive bids until July 28th for improvements to water supply system including a deep well, pump, etc. The Carolina Engineering Co., 917-919 Johnson Bldg., Charlotte, N. C., is engineer.

Tenn., Chattanooga—R. L. Ely, plans the construction of a hotel on Lookout Mountain. Estimated cost $1,000,000.

Tex., New Braunfels—Comal Power Co., E. H. Kifer, Gen. Mgr., San Antonio, subsidiary of the San Antonio Public Service Co., plans to purchase additional electric machinery for power plant here estimated to cost $1,000,000. The Greenwood Co., Boston, Mass., is engineer.

Tex., Port Arthur—City voted $400,000 bonds for the construction of a waterworks system, including pumping machinery. J. O. Herpin, is city engineer.

Tex., San Antonio—S. L. Jeffers, 1 Bushnell Place, plans the construction of a hotel at N. E. cor. Avenue E. and 3rd St. apartment hotel at S. W. cor. Avenue E. and 3rd St. and office and theatre at N. W. cor. Avenue E. and 3rd St., all 12 story. Estimated cost $1,300,000, $1,000,000 and $800,000 respectively. H. T. Phelps, 519 Hicks Bldg., is architect and engineer.

Wis., Racine—Racine Hotel Co., 304 Badger Bldg., awarded contract for the construction of a 7 story hotel at 6th and Main Sts. to Raulf Co., 428 Grand Ave., Milwaukee. Estimated cost $1,000,000.

Wis., Racine—H. W. Voelz, 373 Broadway, Milwaukee, Archt., is preparing plans for the construction of a 2 story dairy plant. Estimated cost $65,000. Owner's name withheld. Refrigeration machinery will be required.

B. C., Vancouver—Fraser Valley Milk Producers Assn., 405 8th Ave. West, will build a 3 story milk plant by day labor. Estimated cost $150,000. P. P. Brown, 410 London Bldg., is engineer. Owner will purchase a 60 ton ammonia compressor and other equipment.